U.S. Department of Energy
Technical Qualification Program

Occupational Safety Qualification Standard

Study Guide

For the

EH Resident Qualification Standard

April 1996

Competency 1.17 **EH residents shall demonstrate a working level knowledge of safety precautions and hazards associated with chemicals, compounds, and compressed gases.**

1. Supporting Knowledge and Skills

a. Discuss the hazards associated with the use of corrosives (acids and alkalies).

b. Describe the general safety precautions necessary for the handling, storage, and disposal of corrosives.

c. Discuss the general safety precautions for toxic compounds.

d. Given a list of compounds, apply appropriate criteria to determine if a compound is a health hazard and discuss the methods by which toxic compounds may enter the body.

e. Discuss the safety precautions for working with cryogenic liquids.

f. Describe the general safety precautions regarding the use, handling, and storage of flammable and combustible materials.

g. Given a specific scenario involving a combustible/flammable material spill, describe the required response. Include containment and notification actions.

h. Describe the requirements for safe storage and use of the following compressed gases (include flammability and cryogenic considerations):
- Oxygen
- Acetylene
- Hydrogen
- Nitrogen

i. Describe the general requirements for the storage of hazardous chemicals (toxic, reactive, and corrosive). Include in your discussion venting/ventilation, drainage, construction, and location.

j. Given a specific activity involving hazardous chemicals, describe the specialized personal protective equipment required.

k. Given examples of specific chemicals, discuss their compatibility and any potential hazards associated with mixing.

l. Describe the safety considerations and hazards associated with the following asbestos-related activities:

- Removal or encapsulation
- Spill and cleanup
- Transportation, storage, or containment
- Disposal

2. Self-Study Activities (corresponding to the intent of the above competency)

NOTES:
- The DOE Orders are in a state of transition. Please refer to the following gopher site for a cross reference of new and old Orders: gopher://VM1.HQADMIN.DOE.GOV:70/00/doemenu1/directiv/251cross.asc
- Below are three web sites containing many of the references you may need.

Web Sites		
Organization	**Site Location**	**Notes**
Department of Energy	http://cted.inel.gov/cted/index.html	DOE Standards, Guides, and Orders.
OSHA	http://www.osha-slc.gov/	OSHA documents and search engine
U.S. House of Representatives	http://law.house.gov/cfr.htm	Searchable Code of Federal Regulations

Review 29 CFR 1910.120, and NIOSH Publication 94-116,

EXERCISE 1.17-A Referring to 29 CFR 1910.120, describe the general hazards associated with corrosive material, providing examples of both types of corrosives.

EXERCISE 1.17-B Referring to NIOSH Publication 94-116, what are the general incompatibilities and reactivitiesfor the following corrosive materials?
- nitric acid
- sulfuric acid
- anhydrous ammonia
- sodium hydroxide

EXERCISE 1.17-C Referring to NIOSH Publication 94-116, what are the general personal protection precautions one must take with the following corrosive materials?

- nitric acid
- sulfuric acid
- anhydrous ammonia
- sodium hydroxide

EXERCISE 1.17-D What are the primary routes and methods of the entry of hazardous chemicals into the human body?

EXERCISE 1.17-E Referring to 29 CFR 1910.120, in the context of hazard identification, define risk assessment.

Scan the tables of contents in 29 CFR 1910.119,

EXERCISE 1.17-F Referring to 29 CFR 1910.119, what are the general elements of a process safety management program that must be implemented when dealing with a highly hazardous chemical?

Read 29 CFR 1910.1200 (e), "Written hazard communication program."

EXERCISE 1.17-G Referring to 29 CFR 1910.1200 (e), what are the general elements of an employer's hazard communication program?

Scan 29 CFR 1910.101, 29 CFR 1910.102, 29 CFR 1910.103, 29 CFR 1910.104, and NIOSH Publication 94-116,

EXERCISE 1.17-H What are the three basic hazards associated with compressed gas cylinders?

EXERCISE 1.17-I Referring to 29 CFR 1910.102 and NIOSH Publication 94-116, what are the health hazards associated with exposure to the compressed gas, acetylene?

EXERCISE 1.17-J Referring to 29 CFR 1910.103 and NIOSH Publication 94-116, what is the placarding required marking for permanent storage areas for the compressed gas, hydrogen?

EXERCISE 1.17-K Referring to 29 CFR 1910.104 and NIOSH Publication 94-116, what is the required distance between compressed oxygen storage systems

and fire-resistive buildings?

Review 49 CFR 171.14, "Transitional Provisions for Implementing Requirements Based on the U.N. Recommendations," and OSHA Standard 2202, Section 21,

EXERCISE 1.17-L Referring to 49 CFR 171.14, what is the difference between combustible liquids and flammable liquids?

EXERCISE 1.17-M Referring to OSHA Standard 2202, describe the general safety precautions regarding the use, handling, and storage of flammable and combustible materials.

EXERCISE 1.17-N Referring to 29 CFR 1910.106, what are the emergency venting requirements for portable storage tanks of flammable and combustible liquids?

EXERCISE 1.17-O Referring to 29 CFR 1910.106, under what circumstances is hot work (e.g., welding or cutting) permitted in a processing plant that contains storage tanks of flammable or combustible liquids?

Read DOE Order 232.1,
read DOE Order 5500.2B,
and **read** pages 1 through 9 in the "Guidance for Event Classification and Emergency Action Levels" in U.S. Department of Energy, Office of Emergency Planning and Operations,

Read the following scenario (adapted from an article in , June 1993 issue) and answer the questions posed in the exercises.

Workers at a chemical distribution company (a DOE contractor) were preparing to empty 20,000-gallon chemical storage tanks for relocation. They were removing the connecting catwalks and ladders using oxygen-acetylene cutting torches, when one of the tanks exploded, lifting it about 30 feet in the air and killing several workers.

EXERCISE 1.17-P Because you were in the vicinity and the first one to respond, what are your immediate actions?

EXERCISE 1.17-Q What is the proper classification of this event, and why?

EXERCISE 1.17-R What are the requirements for oral and written notification by the site/facility to DOE for unusual occurrences?

EXERCISE 1.17-S What are the requirements for oral and written notification by the site/facility to offsite agencies (regional, federal, state, tribal, and local) for unusual occurrences?

Read Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA,
scan
Subpart I, "Personal Protective Equipment," of 29 CFR 1910,
and **read** 29 CFR 1910.120 (g), Engineering controls,
work practices, and personal protective equipment for employee protection, Appendix B, "General Description and Discussion of the Levels of Protection and Protective Gear."

EXERCISE 1.17-T Referring to paragraph (a) of Subpart I, 29 CFR 1910.132, when shall personal protective equipment be provided and used?

EXERCISE 1.17-U Referring to Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA,
what are the
primary and secondary considerations when selecting protective clothing?

EXERCISE 1.17-V Based on EPA protective ensembles, complete the following table by giving at least two examples of recommended equipment for each level of protection.

Levels of Protection Ensembles		
Level	**Protection Provided**	**Recommended Equipment**
A	The highest available level of respiratory, skin, and eye protection.	
B	Same level of respiratory protection but less skin protection than Level A. The minimum level recommended for initial site entries until the hazards have been identified.	
C	Same level of skin protection as Level B, but a lower level of respiratory protection.	
D	No respiratory protection. Minimal skin protection.	

Read 29 CFR 1926.1101, 40 CFR 61, Subpart M, and NIOSH Publication 94-116,

EXERCISE 1.17-W Referring to 29 CFR 1926.1101, what are the permissible exposure limits (both time-weighted average and excursion)?

EXERCISE 1.17-X Referring to 40 CFR 61.145, , what are the required steps to prepare the regulated asbestos-containing material for disposal?

EXERCISE 1.17-Y Referring to 40 CFR 61.150,

, what are the requirements for wetting and preparing asbestos-containing waste for disposal?

EXERCISE 1.17-Z Referring to 40 CFR 61.150,

, what are the requirements for processing asbestos-containing waste into nonfriable forms?

3. Summary

(From

The majority of the occupational health hazards arise from inhaling chemical agents in the form of vapors, gases, dusts, fumes, and mists, or by skin contact with these materials. The degree of risk of handling a given substance depends on the magnitude and duration of exposure. The required information about these chemical hazards can be obtained from the Material Safety Data Sheet (MSDS) that must be supplied by the chemical manufacturer or importer to the purchaser for all hazardous materials that are subject to 29 CFR 1910.1200.

Explosives are those substances, mixtures, or compounds capable of entering into a combustion reaction so rapidly and violently as to cause an explosion. Corrosives are capable of destroying living tissue and have a destructive effect on other substances, particularly on combustible materials; this effect can result in a fire or explosion. Flammable liquids are those liquids with a flash point of 38°C (100°F) or less, although those with higher flash points can be both combustible and dangerous. Toxic chemicals are those gases, liquids, or solids that through their chemical properties, can produce injurious or lethal effects upon contact with body cells. Oxidizing materials are those chemicals that will decompose readily under certain conditions to yield oxygen. They may cause a fire when in contact with combustible materials, and can react violently with water or fire. Dangerous gases are those gases that can cause lethal or injurious effects and damage to property by their toxic, corrosive, flammable, or explosive physical and chemical properties.

The toxicity of a material is not synonymous with its being a health hazard. Toxicity is the capacity of a material to produce injury or harm. Hazard is the possibility that exposure to a material will cause injury when a specific quantity is used under certain conditions. The key elements to be considered when evaluating a health hazard are:

- How much of the material must be in contact with a body cell and for how long to produce injury?
- What is the probability that the material will be absorbed or come in contact with body cells?
- What is the rate of generation of airborne contaminants?
- What control measures are in use?

The effects of exposure to a substance depend on dose, rate, physical state of the substance, temperature, site of absorption, diet, and general state of a person's health.

4. Exercise Solutions

EXERCISE 1.17-A Referring to 29 CFR 1910.120, describe the general hazards associated with corrosive material, providing examples of both types of corrosives.

ANSWER 1.17-A (Any reasonable paraphrase of the following.) Corrosive hazards are substances that cause the deterioration of other materials. A corrosive may eat through and destroy metal, body tissue, plastics, and other materials. Corrosives can be acids or alkali and be in the form of solid, liquid, or gas. Great caution should be taken when working near corrosive materials; they burn on contact and breathing corrosive materials can cause life-threatening damage. Some common corrosives include chlorine, hydrochloric acid, nitric acid, sulfuric acid, anhydrous ammonia, and sodium hydroxide. The strength of a corrosive material is generally measured by how much its pH deviates from neutral (pH 7).

EXERCISE 1.17-B Referring to NIOSH Publication 94-116, what are the general incompatibilities and reactivities for the following corrosive materials?

- nitric acid
- sulfuric acid
- anhydrous ammonia
- sodium hydroxide

ANSWER 1.17-B

- nitric acid - combustible materials, metallic powders, hydrogen sulfide, carbides, alcohols
- sulfuric acid - organic materials, chlorates, carbides, fulminates, water, powdered metals; reacts violently with water and produces heat
- anhydrous ammonia - strong oxidizers, acids, halogens, salts of silver and zinc; corrosive to copper and galvanized surfaces
- sodium hydroxide - water, acids, flammable liquids, organic halogens; corrosive to metals

EXERCISE 1.17-C Referring to NIOSH Publication 94-116, what are the general personal protection precautions one must take with the following corrosive materials?

- nitric acid
- sulfuric acid
- anhydrous ammonia
- sodium hydroxide

ANSWER 1.17-C

- nitric acid - prevent inhalation of vapor, prevent skin contact, prevent eye contact, wash skin on contact, provide eyewash, quick drench
- sulfuric acid - prevent inhalation of vapor, prevent skin contact, prevent eye contact, wash skin on contact, provide eyewash, quick drench
- anhydrous ammonia - prevent inhalation of vapor, prevent skin contact, prevent eye contact, wash skin on contact, provide eyewash, quick drench
- Sodium hydroxide - prevent inhalation of vapor, prevent skin contact, prevent eye contact, wash skin on contact, provide eyewash, quick drench

EXERCISE 1.17-D What are the primary routes and methods of the entry of hazardous chemicals into the human body?

ANSWER 1.17-D

Primary Routes and Methods of Entry	
Route	Description
Inhalation	Involves those airborne contaminants that can be inhaled directly into the lungs and can be physically classified as gases, vapors, and particulate matter, which includes dusts, fumes, smoke, aerosols, and mists.
Absorption	Chemicals can be absorbed through the skin and more rapidly through cut or abraded skin than through intact or unbroken skin. Some substances are absorbed by way of the openings for hair follicles, while others dissolve in the fats and oils of the skin. Some organic chemicals can produce systemic poisoning by direct contact with the skin.
Ingestion	When consumed, the toxic compounds are capable of being absorbed from the gastrointestinal tract into the blood.

EXERCISE 1.17-E Referring to 29 CFR 1910.120, in the context of hazard identification, define risk assessment.

ANSWER 1.17-E (Any reasonable paraphrase is acceptable.) Risk assessment is a determination of the probability that an adverse effect will be produced. Therefore, risk assessment is the basic device by which we should arrive at our decisions governing the handling, use, storage, and disposal of hazardous material.

EXERCISE 1.17-F Referring to 29 CFR 1910.119, what are the general elements of a process safety management program that must be implemented when dealing with a highly hazardous chemical?

ANSWER 1.17-F
1. Hazardous material analysis communications to employees
2. Safety information pertaining to the chemicals, the technology of the process, and equipment used in the process
3. Process hazard analyses conducted
4. Operating procedures
5. Training
6. Prestartup safety review
7. Mechanical integrity
8. Change and modification control

9. Incident investigation
10. Emergency planning and response

EXERCISE 1.17-G Referring to 29 CFR 1910.1200 (e), what are the general elements of an employer's hazard communication program?

ANSWER 1.17-G
1. A list of the hazardous chemicals known to be present
2. The labeling of all hazardous chemical containers
3. A material safety data sheet (MSDS) for each hazardous chemical
4. Employee planning and training

EXERCISE 1.17-H What are the three basic hazards associated with compressed gas cylinders?

ANSWER 1.17-H
- High pressures
- Displacement of breathable air
- Contents that burn or have other hazardous characteristics

EXERCISE 1.17-I Referring to 29 CFR 1910.102 and NIOSH Publication 94-116, what are the health hazards associated with exposure to the compressed gas, acetylene?

ANSWER 1.17-I
- Inhalation - dizziness, asphyxiation
- Eye and skin contact - frostbite

EXERCISE 1.17-J Referring to 29 CFR 1910.103 and NIOSH Publication 94-116, what is the placarding required marking for permanent storage areas for the compressed gas, hydrogen?

ANSWER 1.17-J "HYDROGEN--FLAMMABLE GAS--NO SMOKING--NO OPEN FLAMES" or equivalent.

EXERCISE 1.17-K Referring to 29 CFR 1910.104 and NIOSH Publication 94-116, what is the required distance between compressed oxygen storage systems and fire-resistive buildings?

ANSWER 1.17-K 25 feet.

EXERCISE 1.17-L Referring to 49 CFR 171.14, what is the difference between combustible liquids and flammable liquids?

ANSWER 1.17-L A flammable liquid has a flashpoint below 60° C (140° F). A combustible liquid has a flashpoint above 60° C (140° F) and below 93° C (200° F).

Note:

EXERCISE 1.17-M Referring to OSHA Standard 2202, describe the general safety precautions regarding the use, handling, and storage of flammable and combustible materials.

ANSWER 1.17-M From OSHA 2202, Section 21, "Flammable and Combustible Liquids" (any reasonable paraphrase of the following):

a. Only approved containers and portable tanks shall be used for storage and handling of flammable and combustible liquids.
b No more than 25 gallons of flammable or combustible liquids shall be stored in a room outside of an approved storage cabinet. No more than 60 gallons of flammable or 120 gallons of combustible liquids shall be stored in any one storage cabinet. No more than three storage cabinets may be located in a single storage area.
c. Inside storage rooms for flammable and combustible liquids shall be of fire-resistive construction, have self-construction, have self-closing fire doors at all openings, 4-inch sills or depressed floors, a ventilation system that provides at least six air changes within the room per hour, and electric wiring and equipment approved for Class I, Division 1 locations.

d. Storage in containers outside buildings shall not exceed 1,100 gallons in any one pile or area. The storage area shall be graded to divert possible spills away from building or other exposures, or shall be surrounded by a curb or dike. Storage areas shall be located at least 20 feet from any building and shall be free from weeds, debris, and other combustible materials not necessary to the storage.
e. Flammable liquids shall be kept in closed containers when not actually in use.
f. Conspicuous and legible signs prohibiting smoking shall be posted in service and refueling areas.

EXERCISE 1.17-N Referring to 29 CFR 1910.106, what are the emergency venting requirements for portable storage tanks of flammable and combustible liquids?

ANSWER 1.17-N Each tank is provided with one or more devices to limit internal pressure under fire exposure conditions to 10 psig, or 30% of the bursting pressure of the tank.

EXERCISE 1.17-O Referring to 29 CFR 1910.106, under what circumstances is hot work (e.g., welding or cutting) permitted in a processing plant that contains storage tanks of flammable or combustible liquids?

ANSWER 1.17-O (Any reasonable paraphrase of the following.) Only under supervision of an individual in charge who also has inspected the area to ensure that it is safe for the work to be done and that safe work procedures will be followed.

EXERCISE 1.17-P Because you were in the vicinity and the first one to respond, what are your immediate actions?

ANSWER 1.17-P Depending on how hazardous the material is and the area is,
1. Notify emergency response personnel (e.g., call 911).
2. Assist in the first aid, care, and/or comfort to the level which you have been trained.
3. Until assistance arrives, keep onlookers and passersby away from the accident scene.

EXERCISE 1.17-Q What is the proper classification of this event, and why?

ANSWER 1.17-Q Unusual occurrence, because of loss of life and violation of federal (OSHA) safety requirements.

EXERCISE 1.17-R What are the requirements for oral and written notification by the site/facility to DOE for unusual occurrences?

ANSWER 1.17-R From DOE Order 5500.2B: To DOE HQ EOC within two hours of categorization and in writing within 80 hours.

From DOE Order 232.1: To DOE within two hours of categorization and in writing within 80 hours.

EXERCISE 1.17-S What are the requirements for oral and written notification by the site/facility to offsite agencies (regional, federal, state, tribal, and local) for unusual occurrences?

ANSWER 1.17-S From DOE Order 5500.2B: To offsite agencies within two hours of categorization and in writing in accordance with approved agreements or unusual occurrence procedures.

From DOE Order 232.1: To offsite agencies within two hours of categorization (if DOE 5500.2B is invoked for an emergency) and in writing within 80 hours.

EXERCISE 1.17-T Referring to paragraph (a) of Subpart I, 29 CFR 1910.132, when shall personal protective equipment be provided and used?

ANSWER 1.17-T (Any reasonable paraphrase of the following:) "Whenever it is necessary by reason of hazards of processes or environment, chemical hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation, or physical contact."

EXERCISE 1.17-U Referring to Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USGC/EPA,
what are the primary and
secondary considerations when selecting protective clothing?

ANSWER 1.17-U Primary:

- permeation

- degradation
- penetration
- heat transfer

Secondary:
- durability
- flexibility
- temperature effects
- ease of decontamination
- compatibility with other personal protective equipment
- duration of use

EXERCISE 1.17-V Based on EPA protective ensembles, complete the following table by giving at least two examples of recommended equipment for each level of protection.

ANSWER 1.17-V

Levels of Protection Ensembles		
Level	Protection Provided	Recommended Equipment
A	The highest available level of respiratory, skin, and eye protection.	• Positive-pressure, full face-piece, self-contained breathing apparatus, or positive-pressure, supplied-air respirator with escape SCBA • Totally-encapsulating chemical-protective suit
B	Same level of respiratory protection but less skin protection than Level A. The minimum level recommended for initial site entries until the hazards have been identified.	• Positive-pressure, full face-piece, self-contained breathing apparatus, or positive-pressure, supplied-air respirator with escape SCBA • Hooded, chemical-resistant clothing
C	Same level of skin protection as Level B, but a lower level of respiratory protection.	• Full-face or half-mask air-purifying respirators • Hooded, chemical-resistant clothing
D	No respiratory protection. Minimum skin protection.	• Coveralls • Chemical-resistant, steel toe and shank boots/shoes • Gloves and goggles

EXERCISE 1.17-W Referring to 29 CFR 1926.1101, what are the permissible exposure limits (both time-weighted average and excursion)?

ANSWER 1.17-W Permissible exposure limit (PEL)

- Time-weighted average limit - no employee is exposed to an airborne concentration of asbestos in excess of 0.1 fiber per cubic centimeter (f/cc) of air calculated as an eight-hour time-weighted average.
- Excursion limit - no employee is exposed to an airborne concentration of asbestos in excess of 1.0 fiber per cubic centimeter (f/cc) as averaged over a sampling period of 30 minutes.

EXERCISE 1.17-X Referring to 40 CFR 61.145, ,
what are the required steps to prepare the regulated asbestos-containing

material for disposal?

ANSWER 1.17-X (Any reasonable paraphrase of the following.) Note that there are different standards and procedures for each state.

1. Adequately wet the material and ensure that it remains wet until collected.
2. Carefully lower the material to the ground and floor, not dropping, throwing, sliding, or otherwise damaging or disturbing the material.
3. Transport the material to the ground via leak-tight chutes or containers if it has been removed or stripped more than 50 feet above ground level and was not removed as units or in sections.
4. Double-bag and dispose in approved landfill.

EXERCISE 1.17-Y Referring to 40 CFR 61.150,

, what are the requirements for wetting and preparing asbestos-containing waste for disposal?

ANSWER 1.17-Y (Any reasonable paraphrase of the following.)

1. Wet the asbestos-containing waste material by mixing control device asbestos waste to form a slurry and adequately wet the other asbestos-containing waste material.
2. No visible emissions are discharged to the outside air from collection and processing operations, including incineration, or use of other (specified in §61.152) to clean emissions-containing particulate asbestos material before they escape to, or are vented to, the outside air.
3. After wetting, seal all asbestos-containing waste material in leak-tight containers while wet; for materials that will not fit into containers without additional breaking, put materials into leak-tight wrapping.
4. Label the containers or wrapped materials using OSHA-specified warning labels and markings.

EXERCISE 1.17-Z Referring to 40 CFR 61.150,

, what are the requirements for processing asbestos-containing waste into nonfriable forms?

ANSWER 1.17-Z (Any reasonable paraphrase of the following.)

1. Form all asbestos-containing waste material into nonfriable pellets or other shapes.
2. Discharge no visible emissions to the outside air from collection and processing operations, including incineration, or use of other (specified in §61.152) to clean emissions-containing particulate asbestos material before they escape to, or are vented to, the outside air.

Competency 1.18 **EH residents shall demonstrate the ability to recognize fall hazards and identify the appropriate protective measures and/or systems.**

1. Supporting Knowledge and Skills

a. Describe the requirements for using fall protection equipment.

b. Identify the types of fall protection systems/gear.

c. Given a piece of fall protection equipment, identify the inspection requirements, testing/load ratings, and user training required.

2. Self-Study Activities (corresponding to the intent of the above competency)

NOTE: Below are three web sites containing many of the references you may need.

Web Sites		
Organization	**Site Location**	**Notes**
Department of Energy	http://cted.inel.gov/cted/index.html	DOE Standards, Guides, and Orders.
OSHA	http://www.osha-slc.gov/	OSHA documents and search engine
U.S. House of Representatives	http://law.house.gov/cfr.htm	Searchable Code of Federal Regulations

Review 29 CFR 1910.66, Appendix C, .

Review 29 CFR 1926.500,

Review 29 CFR 1926.100,

Review 29 CFR 1926.104,

Review 29 CFR 1926.105,

Refer to any available materials in completing the following exercises.

EXERCISE 1.18-A When are safety nets required?

EXERCISE 1.18-B Identify at least four of the most common types of fall protection systems/gear.

EXERCISE 1.18-C Select one or more pieces of fall protection equipment used at your site or facility and complete the following matrix.

Fall Protection Equipment				
Equipment	**Inspection Requirements**	**Testing/Load Rating**	**User Training Required**	**Notes**

EXERCISE 1.18-D Define the following terms:

- Anchorage
- Deceleration device
- Free fall
- Personal fall arrest system

3. Summary

The Bureau of Labor Statistics reports that 8% of all occupational fatalities in 1986 were due to falls. Falls are one of the leading causes of traumatic occupational death. A NIOSH analysis of death certificates from work related injuries over a 10-year period has shown falls to be the leading cause of work-related death among construction workers and one of the major causes of injury for the same group. OSHA estimates at least 68,000 injuries occur in the construction industry alone due to falls.

". . . a number of human and equipment-related issues must be addressed to protect employees from fall hazards. Among those issues are the following:

- The need to know when protection is required;
- The election of fall protection systems which are appropriate for given situations;
- The proper construction and installation of safety systems;

- The proper supervision of employees;
- The implementation of safe work procedures; and
- The proper training in the selection, use, and maintenance of fall protection systems."

29 CFR Part 1910 and 1926, "Safety Standards for Fall Protection in the Construction Industry"

4. Exercise Solutions

EXERCISE 1.18-A When are safety nets required?

ANSWER 1.18-A "Safety nets shall be provided when workplaces are more than 25 feet above the ground or water surface, or other surfaces where the use of ladders, scaffolds, catch platforms, temporary floors, safety lines, or safety belts is impractical." 29 CFR 1926.105(a).

EXERCISE 1.18-B Identify at least four of the most common types of fall protection systems/gear.

ANSWER 1.18-B Your answer should include at least four of the following:

- Safety nets
- Safety belts
- Lineman's body belts
- Body harness
- Safety straps
- Lanyards
- Lifelines
- Guardrails
- Handrails

EXERCISE 1.18-C Select one or more pieces of fall protection equipment used at your site or facility and complete the following matrix.

ANSWER 1.18-C Your answer will vary depending upon the equipment in use on your site. An example is provided of a typical response. You may wish to complete the matrix for all identified fall protection equipment to use as a reference on your site.

Fall Protection Equipment				
Equipment	**Inspection Requirements**	**Testing/Load Rating**	**User Training Required**	**Notes**
Safety Net	Immediately prior to and after use	• 17,500 foot-pounds minimum impact resistance • Edge ropes provide a minimum breaking strength of 5,000 pounds	Training required only for net installation	• Must be certified by the manufacturer and bear a label of proof test • Forged steel safety hooks or shackles must be used to support it • Connections between net panels develop the full strength of the net

EXERCISE 1.18-D Define the following terms:

- Anchorage
- Deceleration device
- Free fall
- Personal fall arrest system

ANSWER 1.18-D The following definitions are from 29 CFR 1910.66, Appendix C, "Personal fall arrest system."

Anchorage - a secure point of attachment for lifelines, lanyards, or deceleration devices, that is independent of the means of supporting or suspending the employee.

Deceleration device - any mechanism, such as a rope grab, ripstitch lanyard, specially woven lanyard, tearing or deforming lanyard, or automatic self-retracting lifeline/lanyard, that serves to dissipate a substantial amount of energy during a fall arrest or otherwise limits the energy imposed on an employee during fall arrest.

Free fall - the act of falling before a personal fall arrest system begins to apply force to arrest the fall.

Personal fall arrest system - a system used to arrest an employee in a fall from a working level. It consists of an anchorage, connectors, and a body belt or body harness, and may include a lanyard, deceleration device, lifeline, or suitable combinations of these.

Competency 1.19 **EH residents shall demonstrate a working level knowledge of the requirements for using personal protective equipment (PPE).**

1. Supporting Knowledge and Skills

a. Describe the principles governing the selection, use, and limitations of the following:
- Respirators
- Protective clothing
- Hearing protection devices

b. Describe the various types of personal equipment (devices or clothing) worn to protect a worker from chemical exposure, radiological exposure, and physical injury.

c. Given a work procedure and atmospheric conditions, identify the appropriate type of respiratory protection for the activity.

d. Discuss the following terms as applied to the selection of respiratory equipment:
- Time-weighted average
- Short-term exposure limit
- Threshold limit values
- Immediately dangerous to life and health
- Revised exposure limits
- Protection factor
- Derived air concentration

e. Describe the four levels of protection defined by the Environmental Protection Agency for workers at hazardous waste sites or those workers conducting emergency response activities.

2. Self-Study Activities (corresponding to the intent of the above competency)

NOTE: Below are three web sites containing many of the references you may need.

Web Sites		
Organization	**Site Location**	**Notes**
Department of Energy	http://cted.inel.gov/cted/index.html	DOE Standards, Guides, and Orders.
OSHA	http://www.osha-slc.gov/	OSHA documents and search engine
U.S. House of Representatives	http://law.house.gov/cfr.htm	Searchable Code of Federal Regulations

Read 29 CFR 1910.120 (g), Engineering controls, work practices, and personal protective equipment for employee protection.

EXERCISE 1.19-A Referring to 29 CFR 1910.120 (g), under what general circumstances would the personal protective equipment (PPE) be used as a control measure to reduce and maintain to or below the permissible exposure limits or dose limits?

Read Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA, ; **scan** Subpart I, "Personal Protective Equipment," of 29 CFR 1910, ; and **read** 29 CFR 1910.120 (g), Engineering controls, work practices, and personal protective equipment for employee protection, Appendix B, "General Description and Discussion of the Levels of Protection and Protective Gear."

EXERCISE 1.19-B Referring to paragraph (a) of Subpart I, 29 CFR 1910.132, when shall personal protective equipment be provided and used?

EXERCISE 1.19-C Referring to Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA, , what are the primary and secondary considerations when selecting protective clothing?

EXERCISE 1.19-D Describe the various types and intended purpose of personal protective equipment (PPE).

EXERCISE 1.19-E Referring to Chapter 8, Personal Protective Equipment (PPE), of NIOSH/OSHA/USCG/EPA,
, in the
following table, match (from the following list) the appropriate type of respiratory protection to the given limitation:

- Self-contained breathing apparatus (SCBA)
- Positive-pressure, supplied-air respirator (SAR)
- Air-purifying respirator
- Closed-circuit SCBA
- Escape-only SCBA

Matching Respiratory Protection with Limitation	
Limitation	**Type of Respiratory Protection**
At very cold temperatures, scrubber efficiency may be reduced and CO_2 breakthrough may occur.	
Can only be used against gas and vapor contaminants with adequate warning properties.	
Provides only 5 to 15 minutes of respiratory protection.	
Bulky, heavy, and may impair movement in confined spaces.	
Air line is vulnerable to damage, chemical contamination, and degradation.	

EXERCISE 1.19-F Describe the EPA levels of protection for workers at hazardous material sites, providing at least one condition for each level.

EXERCISE 1.19-G Describe two reasons for upgrading the PPE level of protection.

EXERCISE 1.19-H Based on EPA protective ensembles, complete the following table by giving at least two examples of recommended equipment for

each level of protection.

Levels of Protection Ensembles		
Level	**Protection Provided**	**Recommended Equipment**
A	The highest available level of respiratory, skin, and eye protection.	
B	Same level of respiratory protection but less skin protection than Level A. The minimum level recommended for initial site entries until the hazards have been identified.	
C	Same level of skin protection as Level B, but a lower level of respiratory protection.	
D	No respiratory protection. Minimal skin protection.	

Read paragraphs a through c of 29 CFR 1910.95, , and the corresponding chapters in any comparable fundamentals of industrial hygiene text; **scan** Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA, ; **scan** Subpart I, "Personal Protective Equipment," of 29 CFR 1910, ; **scan** Appendix B, "Methods for Estimating the Adequacy of Hearing Protector Attenuation," of 29 CFR 1910.95, ; and **scan** 29 CFR 1910.120 (g), Engineering controls, work practices, and personal protective equipment for employee protection, Appendix B, "General Description and Discussion of the Levels of Protection and Protective Gear."

EXERCISE 1.19-I What are the four pathways by which sound can reach the inner ear when hearing-protective devices are worn?

EXERCISE 1.19-J Based on OSHA hearing-protection standards, complete the following table listing types (or examples), recommended use, and limitations for the four general categories of hearing-protective devices.

Use and Limitations of Hearing-Protective Devices			
Category	**Types or Examples**	**Recommended Use**	**Limitations**
Enclosures			
Aural inserts			
Superaural protectors			
Circumaural protectors			

EXERCISE 1.19-K What are the primary considerations when selecting the appropriate hearing-protective device?

Read 29 CFR 1910.146 (a and b), , and **scan** NIOSH Pub. No. 80-106, , and ANSI Z88.2-1980, .

Review DOE Order 232.1, ; DOE 5500.2, ; and pages 1 through 9 in the Guidance for Event Classification and Emergency Action Levels in Office of Emergency Planning and Operations, .

Read the following scenario (adapted from article in , July-August 1994 issue) and **answer** the questions posed in the exercises.

A subcontractor worker at a federal facility was inspecting a section of storm drain pipe and entered an underground vault that was connected to the piping. The vault contained about six inches of stagnant, bacteria- and algae-laden water. The worker collapsed after being in the vault for about 10 minutes. An hour later, two passersby climbed into the vault to rescue the worker. They, too, collapsed. Two paramedics, who arrived at the scene, entered the vault and then had to be helped out. Finally, firefighters wearing appropriate breathing apparatus retrieved the dead worker and first rescuer, and resuscitated the second rescuer, who needed to be hospitalized.

EXERCISE 1.19-L What was the likely cause of death for the worker and the rescuer?

EXERCISE 1.19-M What type of breathing apparatus did the firefighters use, and why?

EXERCISE 1.19-N How could this incident have been prevented?

EXERCISE 1.19-O What is the proper classification of this incident, and why?

Read Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA, ; **scan**
Subpart I, "Personal Protective Equipment," of 29 CFR 1910, ; and **read** 29 CFR 1910.120 (g), Engineering controls, work practices, and personal protective equipment for employee protection, Appendix B, "General Description and Discussion of the Levels of Protection and Protective Gear."

EXERCISE 1.19-P Briefly define the following terms related to respiratory protection.

- Threshold limit values
- Time-weighted average
- Short-term exposure limit
- Recommended exposure limit
- Immediately dangerous to life and health
- Protection factor
- Derived air concentration

3. Summary

(From NIOSH/OSHA/USCG/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*)

Use of PPE is required by Occupational Safety and Health Administration (OSHA) regulations in 29 CFR 1910 and 1926 and reinforced by U.S. Environmental Protection Agency (EPA) regulations in 40 CFR 300, all of which include requirements for all private contractors working on Superfund, construction, industrial, and government sites to conform to applicable OSHA provisions and any other federal or state safety requirements deemed necessary by the lead agency overseeing the activities. All supervisors should check the applicable regulations to ensure worker safety and health, and compliance with PPE requirements for various hazards and work activities.

No single combination of protective equipment and clothing is capable of protecting against all hazards. Thus PPE should be used in conjunction with other protective methods. The use of PPE can itself create significant worker hazards, such as heat stress, physical and psychological stress, and impaired vision, mobility, and communication. In general, the greater the level of PPE protection, the greater the associated risks. For any given situation, equipment and clothing should be selected that provide an adequate level of protection. Overprotection as well as underprotection can be hazardous and should be avoided.

4. Exercise Solutions

EXERCISE 1.19-A Referring to 29 CFR 1910.120 (g), under what general circumstances would the personal protective equipment (PPE) be used as a control measure to reduce and maintain to or below the permissible exposure limits or dose limits?

ANSWER 1.19-A Whenever engineering controls and work practices are not feasible or not required, or when contaminant levels have not been reduced using engineering or administrative controls.

EXERCISE 1.19-B Referring to paragraph (a) of Subpart I, 29 CFR 1910.132, when shall personal protective equipment be provided and used?

ANSWER 1.19-B (Any reasonable paraphrase of the following:) "Whenever it is necessary by reason of hazards of processes or environment, chemical hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation, or physical contact."

EXERCISE 1.19-C Referring to Chapter 8, “Personal Protective Equipment (PPE),” of NIOSH/OSHA/USCG/EPA,
, what are the primary and
secondary considerations when selecting protective clothing?

ANSWER 1.19-C

Primary:

- permeation
- degradation
- penetration
- heat transfer

Secondary:

- durability
- flexibility
- temperature effects
- ease of decontamination
- compatibility with other personal protective equipment
- duration of use

EXERCISE 1.19-D Describe the various types and intended purpose of personal protective equipment (PPE).

ANSWER 1.19-D

Types and Purpose of Personal Protective Equipment (PPE)		
Body Part Protected	**PPE**	**Purpose**
Eyes and face	Face shield	Protects against chemical splashes.
	Splash hood	Protects against chemical splashes.
	Safety glasses	Protect eyes against large particles and projectiles.
	Goggles	Can protect against vaporized chemicals, splashes, large particles, and projectiles.
	Sweat bands	Prevents sweat-induced eye irritation and vision impairment.

Types and Purpose of Personal Protective Equipment (PPE)		
Body Part Protected	**PPE**	**Purpose**
Respiratory	Self-contained breathing apparatus	Provides the highest available level of protection against airborne contaminants and oxygen deficiency.
	Supplied-air respirators	Protect against most airborne contaminants.
	Air-purifying respirators	Protect against specific chemicals and up to specific concentrations.
Hands and arms	Gloves and sleeves	Protect hands and arms from chemical contact.
Feet	Safety boots	Protect feet from contact with chemicals and from compression, crushing, or puncture by falling, moving, or sharp objects.
	Disposable shoe or boot covers	Protect safety shoes or boots from contamination.
Head	Safety helmet	Protects head from blows.
	Hood	Protects against chemical splashes, particulates, and rain.
	Protective hair covering	Protects hair against chemical contamination, entanglement in machinery or equipment, or from interfering with vision and with the functioning of respiratory devices.
Full body	Fully encapsulating suit	Protects against splashes, dust, gases, and vapors.
	Nonencapsulating suit	Protects against splashes, dust, and other materials, but not against gases and vapors.
	Aprons, leggings, and sleeve protectors	Provides additional splash protection of chest, forearms, and legs.

EXERCISE 1.19-E Referring to Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA,
, in the following table,
match (from the following list) the appropriate type of respiratory protection to the given limitation:

- Self-contained breathing apparatus (SCBA)
- Positive-pressure, supplied-air respirator (SAR)
- Air-purifying respirator
- Closed-circuit SCBA
- Escape-only SCBA

ANSWER 1.19-E

Matching Respiratory Protection with Condition	
Limitation	**Type of Respiratory Protection**
At very cold temperatures, scrubber efficiency may be reduced and CO_2 breakthrough may occur.	Closed-circuit SCBA
Can only be used against gas, vapor, and particulate contaminants with adequate warning properties.	Air-purifying
Provides only 5 to 15 minutes of respiratory protection.	Escape-only SCBA
Bulky, heavy, and may impair movement in confined spaces.	Self-contained breathing apparatus
Air line is vulnerable to damage, chemical contamination, and degradation.	Positive-pressure, supplied-air respirator

EXERCISE 1.19-F Describe the EPA levels of protection for workers at hazardous material sites, providing at least one condition for each level.

ANSWER 1.19-F

EPA Levels of Protection for Workers	
Level	**Condition**
A	• The hazardous substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system based on either the measured or potential for high concentration. • Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible. • Operations are being conducted in confined, poorly ventilated areas, and the absence of conditions requiring Level A have not yet been determined.
B	• The type and atmospheric concentration of substances have been identified and require the highest level of respiratory protection, but less skin protection. • The atmosphere contains less than 19.5 percent oxygen. • The presence of incompletely identified vapors or gases is indicated by a direct-reading organic vapor-detection instrument, but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the skin.
C	• The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect or be absorbed through any exposed skin. • The types of air contaminants have been identified, concentrations have been measured, and an air-purifying respirator is available that can remove the contaminants. • All criteria for the use of air-purifying respirators are met.
D	• The atmosphere contains no known hazard. • Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.

EXERCISE 1.19-G Describe two reasons for upgrading the PPE level of protection.

ANSWER 1.19-G (Any two of the following:)

- Known or suspected presence of dermal hazards
- Occurrence or likely occurrence of gas or vapor emission
- Change in work task that will increase contact or potential contact with hazardous materials
- Request of the individual performing the task
- Oxygen-deficient atmosphere

EXERCISE 1.19-H Based on EPA protective ensembles, complete the following table by giving at least two examples of recommended equipment for each level of protection.

ANSWER 1.19-H

Levels of Protection Ensembles		
Level	**Protection Provided**	**Recommended Equipment**
A	The highest available level of respiratory, skin, and eye protection.	• Positive-pressure, full face-piece, self-contained breathing apparatus, or positive-pressure, supplied-air respirator with escape SCBA • Totally encapsulating chemical protective suit
B	Same level of respiratory protection but less skin protection than Level A. The minimum level recommended for initial site entries until the hazards have been identified.	• Positive-pressure, full face-piece, self-contained breathing apparatus, or positive-pressure, supplied-air respirator with escape SCBA • Hooded, chemical-resistant clothing
C	Same level of skin protection as Level B, but a lower level of respiratory protection.	• Full-face or half-mask air-purifying respirators • Hooded, chemical-resistant clothing
D	No respiratory protection. Minimal skin protection.	• Coveralls • Chemical-resistant, steel toe and shank boots/shoes

EXERCISE 1.19-I What are the four pathways by which sound can reach the inner ear when hearing-protective devices are worn?

ANSWER 1.19-I
1. Seal leaks
2. Material leaks
3. Hearing-protective device vibration
4. Bone conduction

EXERCISE 1.19-J Based on OSHA hearing protection standards, complete the following table listing types (or examples), recommended use, and limitations for the four general categories of hearing-protective devices.

Use and Limitations of Hearing-Protective Devices			
Category	**Types or Examples**	**Recommended Use**	**Limitations**
Enclosures			
Aural inserts			
Superaural protectors			
Circumaural protectors			

ANSWER 1.19-J

Use and Limitations of Hearing-Protective Devices			
Category	**Types or Examples**	**Recommended Use**	**Limitations**
Enclosures	• Helmets	Enveloping the entire head, this device can accommodate earmuffs and other aural protectors.	Cost, bulk, and practical only in very special applications.
Aural inserts	• Formable • Custom-molded • Premolded	• Rolled into cone and inserted into ear. • Custom-molded to shape of ear. • Require proper fitting by trained person.	• Can be pushed too far into ear canal, and can come loose. • Can come loose. • Performance falls with irregularly-shaped ear canals; also can shrink and become hard from contact with ear wax
Superaural protectors	• Devices that seal the external opening of the ear canal	Held in place by a light band or head suspension.	Can come loose.
Circumaural protectors	• Earmuffs	The attenuation is increased with an increase in force applied; a good seal is dependent upon the width of the contact surface and the material used in the cushion.	Perspiration causes stiffening of the seals.

EXERCISE 1.19-K What are the primary considerations when selecting the appropriate hearing-protective device?

ANSWER 1.19-K (Any three of the following.)
- Attenuation characteristics of the hearing protector (given in the manufacturer's noise reduction rating)
- The individual's work area
- The use of other personal protective equipment
- The frequency of exposure to excessive noise

EXERCISE 1.19-L What was the likely cause of death for the worker and the rescuer?

ANSWER 1.19-L Asphyxiation from lack of oxygen. Bacteria growth and algae decay in the stagnant water produced carbon dioxide that likely displaced the oxygen in the vault.

EXERCISE 1.19-M What type of breathing apparatus did the firefighters use, and why?

ANSWER 1.19-M Self-contained breathing apparatus (SCBA) with full face-piece because the hazardous atmosphere was unknown and the SCBA offers the highest level protection in a confined space.

EXERCISE 1.19-N How could this incident have been prevented?

ANSWER 1.19-N The worker should have been with a buddy and had the piping and vault atmosphere tested prior to entry. The passersby (assuming the worker did not have a buddy and did not have the air tested) should have called 911 for immediate assistance and NOT entered the vault.

EXERCISE 1.19-O What is the proper DOE/OSHA classification of this incident, and why?

ANSWER 1.19-O Unusual occurrence, because of loss of life and violation of federal (OSHA) safety requirements.

EXERCISE 1.19-P Briefly define the following terms related to respiratory protection.

- Threshold limit values
- Time-weighted average
- Short-term exposure limit
- Recommended exposure limit
- Immediately dangerous to life and health
- Protection factor
- Derived air concentration

ANSWER 1.19-P (Any reasonable paraphrase of the following.)

- Threshold limit values - refer to airborne concentrations of substances; and it is believed represent conditions under which nearly all workers may be repeatedly exposed, day after day without adverse effect.
- Time-weighted average - the time-weighted average concentration for a normal 8-hour workday or 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.
- Short-term exposure limit - the maximal concentration to which workers can be exposed for a period of up to 15 minutes continuously without suffering from irritation, chronic or irreversible tissue change, or narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue, or materially reduce work efficiency.
- Recommended exposure limit - time-weighted average concentrations for up to a 10-hour workday during a 40-hour workweek.
- Immediately dangerous to life and health - an atmospheric concentration of any toxic, corrosive, or asphyxiant substance that poses an immediate threat to life or would interfere with an individual's ability to escape from a dangerous atmosphere.
- Protection factor - the level of protection that can be provided by a respirator; a number, which is determined experimentally by measuring face-piece seal and exhalation valve leakage, indicates the relative difference in concentrations of substances outside and inside the facepiece that can be maintained by the respirator.
- Derived air concentration - the average atmospheric concentration of the radionuclide that would lead to the allowable limit on intake in a reference person as a consequence of exposure at that concentration for a 2,000-hour workyear.

Competency 1.20 **EH residents shall demonstrate a familiarity level knowledge of the safety hazards associated with welding.**

1. Supporting Knowledge and Skills

a. Describe the operation and specific hazards associated with the following types of welding processes:
- Shielded
- Arc
- Resistance
- Gas

b. Identify the confined space precautions and mechanical ventilation requirements for welding activities.

c. Discuss the fire prevention precautions during welding activities.

d. Discuss the precautions and requirements for storage and use of compressed gas cylinders used for welding.

2. Self-Study Activities (corresponding to the intent of the above competency)

NOTE: Below are three web sites containing many of the references you may need.

Web Sites		
Organization	**Site Location**	**Notes**
Department of Energy	http://cted.inel.gov/cted/index.html	DOE Standards, Guides, and Orders.
OSHA	http://www.osha-slc.gov/	OSHA documents and search engine
U.S. House of Representatives	http://law.house.gov/cfr.htm	Searchable Code of Federal Regulations

You may refer to any available reference when completing the exercises.

Read 29 CFR 1910.252, .

EXERCISE 1.20-A Describe the specific hazards associated with the following types of welding processes:

- Shielded
- Arc
- Resistance
- Gas

Read 29 CFR 1910.252, (c).

EXERCISE 1.20-B Identify the confined space precautions and mechanical ventilation requirements for welding activities.

Read 29 CFR 1910.252, .

EXERCISE 1.20-C Discuss the fire prevention precautions during welding activities.

Read 29 CFR 1917.152 (d)(1).

EXERCISE 1.20-D Discuss the precautions and requirements for storage and use of compressed gas cylinders used for welding.

EXERCISE 1.20-E When may frozen compressed gas cylinders be thawed with boiling water?

Read 29 CFR 1910.252.

EXERCISE 1.20-F In general welding and cutting, what is the minimum space per welder before mechanical ventilation is required?

3. Summary

Welding is a common activity at many sites and facilities, both during new construction and remodeling, and routine maintenance activities. It is also a common source of accident and injury perhaps due to the significantly different types of hazards it produces. Welding, by its nature, offers myriad opportunities for burns resulting from the torch, slag, splattering metal, the welded object, and welding rods. Particular risks to the eyes are present from the molten metal or from flash burns. Any welding activity may produce toxic fumes either from the welding equipment, rods, etc., or from the item being welded or its contents. Electrical welding adds the risk of electric shock to the other common hazards. Because of the danger involved, there are many standards regulating the welding site, protective clothing and equipment, and ventilation.

4. Exercise Solutions

EXERCISE 1.20-A Describe the specific hazards associated with the following types of welding processes:

- Shielded
- Arc
- Resistance
- Gas

ANSWER 1.20-A Your answer may vary, but should be substantially similar to this. Fire, toxic fumes, eye damage, and burns are hazards common to all welding processes. Gas welding also has cylinder rupture and explosions as an additional hazard. Arc welding has electric shock as an additional hazard.

EXERCISE 1.20-B Identify the confined space precautions and mechanical ventilation requirements for welding activities.

ANSWER 1.20-B Three key factors govern ventilation during welding, the dimensions of the space in which the welding is to be done, the number of welders, and the possible evolution of hazardous fumes, gases, or dust. Confined spaces present particular hazards and require ventilation to keep the maximum allowable concentration of toxic fumes, gases, or dusts below the maximum allowable concentration (specified in 1910.1000). In confined spaces the gas cylinders and welding machines must be left outside, and heavy portable equipment mounted on wheels must be securely blocked. Lifelines, safety belts, airline respirators, fume collectors, exhaust ventilators, and watchers are also advised or required, depending upon the situation.

EXERCISE 1.20-C Discuss the fire prevention precautions during welding activities.

ANSWER 1.20-C The two basic classes of fire prevention precautions are dealing with fire hazards and use of fire guards. If the object to be welded or cut cannot be readily moved, then all movable fire hazards in the vicinity should be taken to a safe place. If this is not possible, then fire guards should be used to confine the heat, sparks, and slag, and to protect the immovable fire hazards. Use of fire extinguishers and a fire watch are appropriate in some situations.

EXERCISE 1.20-D What is the minimum separation in storage of oxygen cylinders from fuel gas cylinders and combustible materials?

ANSWER 1.20-D The minimum safe distance is 20 feet or a barrier having a fire-resistance rating of 30 minutes.

EXERCISE 1.20-E When may frozen compressed gas cylinders be thawed with boiling water?

ANSWER 1.20-E "Gas welding and cutting. (1) Compressed gas cylinders: . . . (ix) Shall not be thawed by boiling water;" 29 CFR 1917.152 (d)

EXERCISE 1.20-F In general welding and cutting, what is the minimum space per welder before mechanical ventilation is required?

ANSWER 1.20-F "General. Mechanical ventilation shall be provided when welding or cutting is done on metals not covered in paragraphs (5) through (12) of this section. . . (A) In a space of less than 10,000 cubic feet (284m(3)) per welder." 29 CFR 1910.252(c)(2)(i)(A)

Competency 1.21 **EH residents shall demonstrate a familiarity level knowledge of the safety hazards associated with materials handling and storage.**

1. Supporting Knowledge and Skills

a. Describe the safety hazards associated with crane and gantry operation during material handling and storage activities.

b. Describe the purpose of the load rating.

c. Describe the purpose of the Safety Bulletin on Suspect/Substandard Parts.

d. Discuss the limitations associated with stacking material.

e. Discuss the preventive measures to avoid the following storage area hazards:
- Tripping
- Fire
- Explosion
- Spills

2. Self-Study Activities (corresponding to the intent of the above competency)

NOTE: Below are three web sites containing many of the references you may need.

Web Sites		
Organization	**Site Location**	**Notes**
Department of Energy	http://cted.inel.gov/cted/index.html	DOE Standards, Guides, and Orders.
OSHA	http://www.osha-slc.gov/	OSHA documents and search engine
U.S. House of Representatives	http://law.house.gov/cfr.htm	Searchable Code of Federal Regulations

Read 29 CFR 1910, Subpart N, "Materials Handling and Storage."

Read 29 CFR 1910.179, Overhead and Gantry Cranes.

Review DOE/ID-10500, Hoisting and Rigging Manual.

Read Environment, Safety and Health Safety Bulletin, 93-6, DOE/EH-0342, "Take Special Care When Using Cranes."

EXERCISE 1.21-A Describe the safety hazards associated with crane and gantry operation during material handling and storage activities.

EXERCISE 1.21-B Describe the purpose of the load rating.

Read Environment, Safety and Health Safety Bulletin, 92-4, DOE/EH-0266, "DOE Quality Alert."

EXERCISE 1.21-C According to the safety bulletin, what are the two most common problems with counterfeit parts?

Review 29 CFR 1926.250, Materials handling, storage, use, and disposal.

EXERCISE 1.21-D Referring to 29 CFR 1926.250, in a building under construction, what is the requirement for material storage relative to hoist ways or inside floor openings?

EXERCISE 1.21-E Referring to 29 CFR 1926.250, what are the requirements for stacking bricks?

Review 29 CFR 1926.250, [redacted]

EXERCISE 1.21-F Referring to 29 CFR 1926.250, what are the requirements for lumber storage?

Review 29 CFR 1926.250, (a)(3).

Review 29 CFR 1926.500.

Review 29 CFR 1926.252.

Read Environment, Safety and Health Safety Bulletin, 92-1, DOE/EH-0247, "Preventable injuries: Indoor slips and falls."

EXERCISE 1.21-G Discuss the preventive measures to avoid the following storage area hazards:

- Tripping
- Fire
- Explosion
- Spills

3. Summary

There are many safety hazards associated with materials handling and storage that vary with the materials under consideration. Some of the most common safety-related issues are those dealing with crane and gantry operation, stacking of stored materials, and housekeeping issues. This competency covers a wide variety of handling and storage issues, but focuses on those considered to be most significant to worker safety.

During the decade ending in 1992, an average of 10 crane-related injuries and 1,200 lost work days were reported each year at DOE facilities. A total of 111 fatalities occurred in the United States between 1985 and 1989. The most common cause of crane accidents is contact with power lines. Fatal crane accidents are generally the result of electrocution. One-fourth of all nonfatal crane-related injuries reported occurred during rigging or maintenance activities.

"The use of cranes, forklifts, hoists, in-plant powered industrial trucks, and slings is subject to certain hazards that cannot be controlled by mechanical means. Only by the exercise of intelligence, care, and good sense can these hazards be met. It is essential to have competent and careful operators, physically and mentally fit, thoroughly trained to the safe operation of the equipment and the handling of the loads. Serious hazards are overloading, dropping or slipping of the load caused by improper hitching or slinging, obstruction to the free passage of the load, or using equipment for a purpose for which it was not intended or designed." DOE/ID-10500, [illegible]2.1, "Operator Training."

This information is from DOE/EH-0266, Issue No. 92-4, [illegible] "As of June 1992, DOE contractors have reported finding in excess of 1,000,000 suspect/counterfeit bolts." An additional 700 suspect/counterfeit circuit breakers have also been reported. The U.S. Customs Service has prepared a Headmark List of bolts that should be considered suspect/counterfeit. Any bolts in the DOE community that are on the list should be rejected. Several other cautions are relevant. "Given the expense of removing suspect bolts from DOE facilities, the practice of using suspect bolts for any application should be stopped." Also, "all bolts purchased should be kept in the original packages, not emptied into bins."

4. Exercise Solutions

You may refer to any available references when completing the exercises.

EXERCISE 1.21-A Describe the safety hazards associated with crane and gantry operation during material handling and storage activities.

ANSWER 1.21-A Serious hazards are overloading, dropping or slipping of the load caused by improper hitching or slinging, obstruction to the free passage of the load, or using equipment for a purpose for which it was not intended or designed." DOE/ID-10500, [illegible]2.1,
"Operator Training."

"A common cause of crane accidents involves contact with power lines. Fatal crane accidents are generally the result of electrocution."
[illegible]93-6, DOE/EH-0342,
"Take Special Care When Using Cranes."

EXERCISE 1.21-B Describe the purpose of the load rating.

ANSWER 1.21-B Each crane is required to have a rated capacity marked on the side of the crane to provide the operator with the information necessary for safe operation. The load rating provides the maximum working load allowed for the crane. A crane may not be loaded beyond its rated capacity except for test purposes.

EXERCISE 1.21-C According to the safety bulletin, what are the two most common

problems counterfeit parts?

ANSWER 1.21-C The two most common in counterfeit substandard parts are high-strength bolts and circuit breakers.

EXERCISE 1.21-D Referring to 29 CFR 1926.250, in a building under construction, what is the requirement for material storage relative to hoist ways or inside floor openings?

ANSWER 1.21-D "Material storage. (1) Material stored inside buildings under construction shall not be placed within six feet of any hoist way or inside floor openings, . . ." 29 CFR 1926.250, (b)

EXERCISE 1.21-E Referring to 29 CFR 1926.250, what are the requirements for stacking bricks?

ANSWER 1.21-E "Brick stacks shall not be more than seven feet in height. When a loose brick stack reaches a height of four feet, it shall be tapered back two inches in every foot of height above the 4-foot level." 29 CFR 1926.250, (b)(3)(6)

EXERCISE 1.21-F Referring to 29 CFR 1926.250, what are the requirements for lumber storage?

ANSWER 1.21-F "(i) Used lumber shall have all nails withdrawn before stacking.
(ii) Lumber shall be stacked on level and solidly supported sills.
(iii) Lumber shall be so stacked as to be stable and self-supporting.
(iv) Lumber piles shall not exceed 20 feet in height provided that lumber to be handled manually shall not be stacked more than 16 feet high." 29 CFR 1926.250, (b)(8)

EXERCISE 1.21-G Discuss the preventive measures to avoid the following storage area hazards:

- Tripping
- Fire
- Explosion
- Spills

ANSWER 1.21-G The single most critical issue in storage area accident prevention is housekeeping. "Storage areas shall be kept free from accumulation of materials that constituted hazards from tripping, fire, explosion, or pest harborage. Vegetation control will be exercised when necessary." 29 CFR 1926.250, C. Your answer may vary but should contain substantially the same information as that shown in the chart.

Storage Area Hazards and Preventive Measures	
Hazard	**Preventive Measure**
Tripping	Housekeeping and proper illumination are key to avoiding tripping hazards. "Aisles and passageways shall be kept clear to provide for the free and safe movement of material handling equipment or employees. Such areas shall be kept in good repair." 29 CFR 1926.250, (a)(3) Additionally, 29 CFR 1926.500, "Guardrails, handrails, and covers," provides the requirements for these safety items.
Fire	Housekeeping (including proper segregation of materials), appropriate fire protection equipment, and proper employee training are the primary considerations in storage areas for fire protection. "All solvent waste, oily rags, and flammable liquids shall be kept in fire-resistant, covered containers until removed from the worksite." 29 CFR 1926.252, (e) Additionally, some materials such as hazardous waste, radioactive materials, and flammable and combustible liquids have particular regulations and restrictions relevant to fire protection. The OSHA requirements for flammable and combustible liquids are found in 29 CFR 1910.106.
Explosion	Review Competency 1.14 on explosives safety for appropriate assistance with this response. The OSHA requirements for flammable and combustible liquids found in 29 CFR 1910.106 also deal with the explosive hazards presented by these materials.

Storage Area Hazards and Preventive Measures	
Hazard	**Preventive Measure**
Spills	Spills are the source of several on-the-job hazards. Spills of flammable or combustible liquids may cause fires. Spills of caustic or corrosive materials may cause burns or skin and eye damage. Other spills may result in tripping or falls. Housekeeping is the critical factor in spills hazard reduction, but emphasis must also be placed on training. "(i) General. Maintenance and operating practices shall be in accordance with established procedures that will tend to control leakage and prevent the accidental escape of flammable or combustible liquids. Spills shall be cleaned up promptly." 29 CFR 1910.106 (e) (8) "The floor of every workroom shall be maintained in a clean and, so far as possible, dry condition." 29 CFR 1910.22(a)(2)

Competency 1.22 **EH residents shall demonstrate a familiarity level knowledge of the safety hazards associated with machinery and machine guarding.**

1. Supporting Knowledge and Skills

a. Given a specific type of machine, identify the potential hazards and appropriate guards associated with the following:
- Pinch points
- Point of operation
- Reciprocating components
- Rotating components

b. Describe the purpose and typical use of each of the following types of barriers:
- Physical
- Location (distance)
- Electronic
- Magnetic
- Procedural/administrative controls
- Special tools

2. Self-Study Activities (corresponding to the intent of the above competency)

NOTE: Below are three web sites containing many of the references you may need.

Web Sites		
Organization	**Site Location**	**Notes**
Department of Energy	http://cted.inel.gov/cted/index.html	DOE Standards, Guides, and Orders.
OSHA	http://www.osha-slc.gov/	OSHA documents and search engine
U.S. House of Representatives	http://law.house.gov/cfr.htm	Searchable Code of Federal Regulations

Read the summary section below.

Review Title 29 CFR 1910, Subpart O.

EXERCISE 1.22-A Select a specific type of mechanical equipment and complete a table similar to the one below for it.

Type	Potential Hazards	Guards
Pinch Points		
Point of Operation		
Reciprocating Components		
Rotating Components		

EXERCISE 1.22-B State the purpose and typical use for each of the following types of barriers:

- Physical
- Location (distance)
- Electronic
- Magnetic
- Procedural/administrative controls
- Special tools

3. Summary

Competency 1.22 deals with occupational safety hazards associated with machinery and machine guarding. The primary reference for this competency is Title 29 CFR 1910, Subpart O. This regulation covers a broad spectrum of mechanical equipment as well as a variety of safety measures used for each. It is, therefore, not possible to cover all pieces or even types of equipment or their safety features in this self-study guide. The purpose of this guide, therefore, is to relate some general pieces of information regarding these topics.

Hazards

29 CFR 1910, Subpart O, covers various types of hazards. This guide covers the following:

- Pinch points
- Point of operation
- Reciprocating components
- Rotating components

Pinch Points

The primary potential hazard related to pinch points is damage to hands and fingers from pinching or falling parts. Several types of guards can be used to minimize that hazard. The following list identifies some of those.

- Friction brakes
- Mechanical guards to prevent access
- Gates or movable barriers
- Workpiece rests and clamps
- Machine location
- Point of operation

The primary potential hazards related to the point of operation are damage to hands and fingers from pinching or falling parts, damage to eyes and other bodily injury from leaking lubrication or flying parts, and bodily injury from clothing catching on moving parts. Several types of guards can be used to minimize those hazards. The following list identifies some of those.

- Friction brakes
- Protected foot pedals
- Hand-operated levers with spring latches
- Two-hand trips
- Lockable power disconnects
- Protected motor start buttons
- Gates or movable barriers
- Presence sensing devices
- Blade guards
- Workpiece rests and clamps
- Machine location
- Shut-off valves

Reciprocating Components

The primary potential hazards related to the point of operation are damage to hands and fingers from pinching or falling parts and damage to eyes and other bodily injury from leaking lubrication or flying parts. Several types of guards can be used to minimize those hazards. The following list identifies some of those.

- Friction brakes
- Protected foot pedals
- Hand-operated levers with spring latches

- Lockable power disconnects
- Protected motor start buttons
- Gates or movable barriers
- Blade guards
- Work piece rests and clamps
- Machine location
- Components

The primary potential hazards related to the point of operation are bodily injury from clothing catching on rotating parts and damage to eyes and other bodily injury from flying parts. Several types of guards can be used to minimize those hazards. The following list identifies some of those.

- Protected foot pedals
- Lockable power disconnects
- Protected motor start buttons
- Gates or movable barriers
- Blade guards
- Work piece rests and clamps
- Machine location
- Shut-off valves

Barriers

Barriers minimize the risk of occupational injury. The following are covered by this self-study guide:

- Physical
- Location (distance)
- Electronic
- Magnetic
- Procedural/administrative controls
- Special tools

Physical

The purpose of physical barriers is to reduce the probability of injury by limiting access to dangerous areas or components. One typical use of this type of barrier is a mechanical guard that prevents contact with pinch points or moving parts.

Location (distance)

Location barriers reduce the probability of injury by ensuring that sufficient distance exists between the equipment and other material, equipment, structures, or personnel. Typically, the location of guards is such that additional pinch points are not created and that maximum protection is provided for the worker. Equipment is located so that the surrounding environment does not produce an additional safety hazard by the location of that equipment. When possible, machinery is located away from the normal work areas.

Electronic

The purpose of electronic barriers is to reduce the probability of injury by controlling the operation of the equipment or by causing shutdowns under certain conditions. Electronics are also an integral part of several types of guards. Typical uses include electronic speed controllers, presence detectors, proximity detectors, overspeed devices, and overcurrent devices.

Magnetic

Magnetic barriers reduce the probability of injury by preventing material from slipping while being worked. Additional uses of magnetic barriers include electronic speed controllers, presence detectors, and proximity detectors.

Procedural/administrative controls

Procedural and administrative controls help to reduce the probability of injury by establishing operation- and maintenance-related safety rules. Although the establishment of rules does not directly improve safety, the adherence to those rules certainly can. Typically, safety procedures include operational and maintenance guidance for detailed work, specific safety steps, and general safety policy.

Special tools

The purpose of special tools is to reduce the probability of injury by providing safer, alternative means for the machine operator to perform activities. Special tools are normally used to handle safety needs that are specific to individual equipment or types of equipment. For more information, refer to the [redacted]
developed by the Department of Energy's Oak Ridge Operations Office.

4. Exercise Solutions

EXERCISE 1.22-A Select a specific type of mechanical equipment and complete a table similar to the one below for it.

ANSWER 1.22-A The answer to this exercise is time-dependent, site-specific, and will vary widely with the selection of equipment. There are a large number of possible correct answers to this exercise. There is, however, information that applies to most equipment of a specific hazard type. The table below shows some, but not all, of those possible answers.

Occupational Hazards from Machinery and Their Mitigation		
Type	**Potential Hazards**	**Guards**
Pinch Points	• Damage to hands and fingers from pinching or falling parts.	Friction brakes Mechanical guards to prevent access Gates or movable barriers Workpiece rests and clamps Machine location
Point of Operation	• Damage to hands and fingers from pinching or falling parts. • Damage to eyes and other bodily injury from leaking lubrication or flying parts. • Bodily injury from clothing catching on moving parts.	Friction brakes Protected foot pedals Hand-operated levers with spring latches Two-hand trips Lockable power disconnects Protected motor start buttons Gates or movable barriers Presence-sensing devices Blade guards Workpiece rests and clamps Machine location Shut-off valves

Occupational Hazards from Machinery and Their Mitigation		
Type	**Potential Hazards**	**Guards**
Reciprocating Components	• Damage to hands and fingers from pinching or falling parts. • Damage to eyes and other bodily injury from leaking lubrication or flying parts.	Friction brakes Protected foot pedals Hand-operated levers with spring latches Lockable power disconnects Protected motor start buttons Gates or movable barriers Blade guards Workpiece rests and clamps Machine location
Rotating Components	• Bodily injury from clothing catching on rotating parts. • Damage to eyes and other bodily injury from flying parts.	Protected foot pedals Lockable power disconnects Protected motor start buttons or movable barriers Blade guards Workpiece rests and clamps Machine location Shut-off valves

EXERCISE 1.22-B State the purpose and typical use for each of the following types of barriers:

- Physical
- Location (distance)
- Electronic
- Magnetic
- Procedural/administrative controls
- Special tools

ANSWER 1.22-B There are many possible answers for this question. The following list identifies some, but not all, of those possible answers.

Physical

Purpose -- Reduce the probability of injury by limiting access to dangerous areas or components.

Typical Use -- Mechanical guards that prevent contact with pinch points or moving parts.

Location (distance)

Purpose -- Reduce the probability of injury by ensuring that sufficient distance exists between the equipment and other material, equipment, structures, or personnel.

Typical Use -- Location of guards is such that additional pinch points are not created and to provide the maximum protection for the worker. Equipment is located so that the surrounding environment does not produce an additional safety hazard by the location of that equipment. When possible, machinery is located away from the normal work areas.

Electronic

Purpose -- Reduce the probability of injury by controlling the operation of the equipment or by causing shutdowns under certain conditions. Electronics are also an integral part of several types of guards.

Typical Use -- Electronic speed controllers, presence detectors, proximity detectors, overspeed devices, and overcurrent devices.

Magnetic

Purpose -- Reduce the probability of injury by preventing material from slipping while being worked. In some cases, magnetics are also used in the determination of presence or proximity.

Typical Use -- Electronic speed controllers, presence detectors, and proximity detectors.

Procedural/administrative controls

Purpose -- Reduce the probability of injury by establishing operation- and maintenance-related safety rules.

Typical Use -- Operational and maintenance guidance for detailed work, specific safety steps, and general safety policy.

Special tools

Purpose -- Reduce the probability of injury by providing safer, custom-designed means for the machine operator to perform activities.

Typical Use -- Handle safety needs that are specific to individual equipment or types of equipment.

Competency 1.23 **EH residents shall demonstrate a familiarity level knowledge of the safety hazards associated with hand and portable tools.**

1. Supporting Knowledge and Skills

a. Describe the general requirements for safe operation of hand and portable tools.

b. Describe the purpose of the following types of protection associated with hand and portable tools:
- Constant pressure switch
- Grounding
- Personal protective equipment
- Procedural/administrative controls
- Shutoff device

2. Self-Study Activities (corresponding to the intent of the above competency)

NOTE: Below are three web sites containing many of the references you may need.

Web Sites		
Organization	**Site Location**	**Notes**
Department of Energy	http://cted.inel.gov/cted/index.html	DOE Standards, Guides, and Orders.
OSHA	http://www.osha-slc.gov/	OSHA documents and search engine
U.S. House of Representatives	http://law.house.gov/cfr.htm	Searchable Code of Federal Regulations

Read the summary.

Review 29 CFR 1926, Subpart I.

Review DOE/ID-10600, Section 2.0.

EXERCISE 1.23-A In your own words, describe at least five general requirements for safe operation of hand and portable tools.

EXERCISE 1.23-B State the purpose for each of the following types of protection associated with hand and portable power tools:

- Constant pressure switch
- Grounding
- Personal protective equipment
- Procedural/administrative controls
- Shutoff device

3. Summary

Title 29 CFR 1926, Subpart I, covers a broad spectrum of tools as well as a variety of safety measures. It is, therefore, not possible to cover all pieces or even types of equipment or their safety features in this self-study guide. The purpose of this guide, therefore, is to relate some general safety considerations applicable to the majority of hand and portable tools.

General Safety Requirements

Title 29 CFR 1926, Subpart I, covers various types of hazards and safety standards. A list of specific safety requirements could be lengthy and not very useful; rather, the following list (taken from DOE/ID-10600, Section 2.0), provides some general requirements.

- Determine the work content and the sequence in which it should be accomplished.
- Identify the safety procedures that shall be followed.
- Ensure that the tools and instruments are in good working order and have up-to-date calibration as required.
- Identify which tools are required and ensure that all workers know how to use them.
- Identify protective equipment required to perform the job safely.
- Allow only qualified individuals to operate tools and equipment.
- Select and post safety signs, symbols, or accident prevention tags to warn and protect employees where hazards are likely to endanger lives.
- Use barricades in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas where they might be exposed to uninsulated energized conductors or circuit parts. Do not use metal barricades where they are likely to cause an electrical contact hazard.
- Use manual signaling and alerting to warn and protect employees when signs and barricades do not provide sufficient warning and protection from hazards.
- Limit the work area to authorized individuals who are familiar with the work. Do not allow unauthorized individuals into the work area.

- Ensure that all individuals who are involved in the work are notified of any changes in the work conditions.
- Report unsafe conditions that develop during the work process immediately to the person in charge or the immediate supervisor.

4. Exercise Solutions

EXERCISE 1.23-A In your own words, describe at least five general requirements for safe operation of hand and portable tools.

ANSWER 1.23-A There are a large number of possible correct answers to this exercise. The list below shows some, but not all, of those possible answers.

- Determine the work content and the sequence in which it should be accomplished.
- Identify the safety procedures that shall be followed.
- Ensure that the tools and instruments are in good working order and have up-to-date calibration as required.
- Identify which tools are required and ensure that all workers know how to use them.
- Identify protective equipment required to perform the job safely.
- Allow only qualified individuals to operate tools and equipment.
- Select and post safety signs, symbols, or accident prevention tags to warn and protect employees where hazards are likely to endanger lives.
- Use barricades in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas where they might be exposed to uninsulated energized conductors or circuit parts. Do not use metal barricades where they are likely to cause an electrical contact hazard.
- Use manual signaling and alerting to warn and protect employees when signs and barricades do not provide sufficient warning and protection from hazards.
- Limit the work area to authorized individuals who are familiar with the work. Do not allow unauthorized individuals into the work area.
- Ensure that all individuals who are involved in the work are notified of any changes in the work conditions.
- Report unsafe conditions that develop during the work process immediately to the person in charge or the immediate supervisor.

EXERCISE 1.23-B State the purpose for each of the following types of protection associated with hand and portable power tools:

- Constant pressure switch
- Grounding
- Personal protective equipment
- Procedural/administrative controls
- Shutoff device

ANSWER 1.23-B

Hand and Power Tool Protection Devices	
Control	**Purpose**
Constant pressure switch	To protect personnel by shutting off the power to the tool when the pressure is released
Grounding	To protect personnel from the hazard of electrical shock or electrocution
Personal protective equipment	To protect personnel from the hazards such as falling, flying, abrasive, and splashing objects or exposure to harmful dusts, fumes, mists vapors, or gases
Procedural/administrative controls	To protect personnel from hazards associated with improper use of hand and portable tools by establishing rules and requirements that limit exposure to those hazards
Shutoff device	To prevent or minimize the damage to personnel by shutting off the power or other source of energy to the tool

Competency 1.24 **EH residents shall demonstrate a familiarity level knowledge of the safety hazards associated with walking and working surfaces.**

1. Supporting Knowledge and Skills

a. Describe the general requirements for safe operation of the following work areas or activities:
- Aisles and passageways
- Floors and wall openings and holes
- Housekeeping

b. Describe the safety requirements for stair and handrail construction.

c. Describe the safety requirements for construction, care, and use of ladders.

d. Describe the general safety requirements for construction, overhead protection, and use of scaffolds.

2. Self-Study Activities (corresponding to the intent of the above competency)

NOTE: Below are three web sites containing many of the references you may need.

Web Sites		
Organization	**Site Location**	**Notes**
Department of Energy	http://cted.inel.gov/cted/index.html	DOE Standards, Guides, and Orders.
OSHA	http://www.osha-slc.gov/	OSHA documents and search engine
U.S. House of Representatives	http://law.house.gov/cfr.htm	Searchable Code of Federal Regulations

Read the summary section below.

Review 29 CFR 1910, Subpart D, [redacted]

Review 29 CFR 1926, Subpart H, [redacted]

Review 29 CFR 1926, Subpart M, [illegible]

Review 29 CFR 1926, Subpart C, [illegible]

Review 29 CFR 1926, Subpart L, [illegible]

EXERCISE 1.24-A Describe the general occupational safety-related requirements related to the following work areas or activities:

- Aisles and passageways
- Floors and wall openings and holes
- Housekeeping

Review 29 CFR 1926, Subpart X, [illegible]

EXERCISE 1.24-B While referring to 29 CFR 1910, Subpart D, describe the safety requirements for stair and handrail construction. Include each of the following in your discussion.

Handrails

- Protection for floor openings
- Protection for wall openings and holes
- Protection of open-sided floors, platforms, and runways
- Stairway railings and guards

Stairs

- Where stairs are required
- Stair strength
- Stair width
- Angle of stairway rise
- Stair treads
- Stairway platforms
- Vertical clearance

EXERCISE 1.24-C Using Title 29 CFR 1910, Subpart D, identify the topics covered by safety requirements for construction, care, and use of ladders.

Review 29 CFR 1926, Subpart L, [illegible]

EXERCISE 1.24-D Using 29 CFR 1910, Subpart D, identify at least five types of scaffolds covered.

3. Summary

Title 29 CFR covers a broad spectrum of walking and working surfaces as well as a variety of safety measures. Part 1910, Subpart D, provides that coverage for operating facilities, while these topics related to construction projects are covered by the following Subparts of Part 1926:

- H --
- M --
- C --
- X --

4. Exercise Solutions

EXERCISE 1.24-A Describe the general occupational safety related requirements related to the following work areas or activities:

- Aisles and passageways
- Floors and wall openings and holes
- Housekeeping

ANSWER 1.24-A

General Safety Requirements	
Work Area/Activity	**Requirements**
Aisles and passageways	• Where mechanical handling equipment is used, sufficient safe clearances shall be allowed for aisles, at loading docks, through doorways and wherever turns or passage must be made. • Aisles and passageways shall be kept clear and in good repair, with no obstruction across or in aisles that could create a hazard. • Permanent aisles and passageways shall be appropriately marked.
Floors and wall openings and holes	• Covers and/or guardrails shall be provided to protect personnel from the hazards of open pits, tanks, vats, ditches, etc.

General Safety Requirements	
Work Area/Activity	**Requirements**
Housekeeping	• All places of employment, passageways, storerooms, and service rooms shall be kept clean and orderly and in a sanitary condition. • The floor of every workroom shall be maintained in a clean and, so far as possible, dry condition. • Where wet processes are used, drainage shall be maintained, and false floors, platforms, mats, or other dry standing places should be provided where practicable. • To facilitate cleaning, every floor, working place, and passageway shall be kept free from protruding nails, splinters, holes, or loose boards.

EXERCISE 1.24-B While referring to 29 CFR 1910, Subpart D, describe the safety requirements for stair and handrail construction. Include each of the following in your discussion.

Handrails
- Protection for floor openings
- Protection for wall openings and holes
- Protection of open-sided floors, platforms, and runways
- Stairway railings and guards

Stairs
- Where stairs are required
- Stair strength
- Stair width
- Angle of stairway rise
- Stair treads
- Stairway platforms
- Vertical clearance

ANSWER 1.24-B

Safety Requirements for Stairs and Handrails	
Handrails	**Requirements**
NOTE: In some of the following cases, guards or barriers other than or in addition to handrails may be used. In general, however, handrails shall exist to provide guarding in the following situations.	
Protection for floor openings	• Stairway floor openings • Ladderway floor openings or platforms • Hatchways and chute floor openings • Skylight floor openings and holes • Pits and trapdoor floor openings • Manhole floor openings • Temporary floor openings • Other floor holes into which persons can walk
Protection for wall openings and holes	• Wall openings • Chute wall openings • Window wall openings at a stairway landing, floor platform, or balcony • Temporary wall openings • Where there is a hazard of materials falling through the wall hole
Protection of open-sided floors, platforms, and runways	• Open-sided floors or platforms • Runways • Open-sided floors, walkways, platforms, or runways above or adjacent to dangerous equipment
Stairway railings and guards	• Flight of stairs • Winding stairs

Safety Requirements for Stairs and Handrails	
Stairs	**Requirements**
NOTE: In some of the following cases of fixed, general industrial stairs, guards other than or in addition to handrails may be used. In general, however, handrails shall exist to provide guarding in the following situations.	
Where stairs are required	• For access from one structure level to another where operations necessitate regular travel between levels • For access to operating platforms at any equipment that requires attention routinely during operations • Where access to elevations is daily or at each shift for such purposes as gauging, inspection, regular maintenance, etc., where such work may expose employees to acids, caustics, gases, or other harmful substances, or for which the carrying of tools or equipment by hand is normally required. • Spiral staircases shall not be permitted except for special, limited usage and secondary access situations where it is not practical to provide a conventional stairway.
Stair design	• Stair strength • Stair width • Angle of stairway rise • Stair treads • Stairway platforms • Vertical clearance

EXERCISE 1.24-C Using 29 CFR 1910, Subpart D, identify the topics covered by safety requirements for construction, care, and use of ladders.

ANSWER 1.24-C

Safety Requirements for Ladders	
Portable Wood Ladders	**Topics Of Requirements**
Construction	• Materials/types defined • Length of each type • Stepladder step spacing • Width between side rails of stepladders • Holding the stepladder open
Care	• General condition maintenance • Bearing lubrication • Rope condition • Safety feet • Inspections/discarding of defective ladders • Rung condition
Use	• Placement of the ladder • Use of ladders • Splicing together short ladders to provide longer sections prohibited • Climbing on the bracing on the back legs of step ladders prohibited

Safety Requirements for Ladders	
Portable Metal Ladders	**Requirements**
Construction	• Types • Metal selection • Stepladder step spacing • Slip-resistance of rungs and steps • Width between side rails of stepladders • Length of each type • Positive stops • Holding the stepladder open
Care	• General condition maintenance • Inspections/repair • Free of slippery materials
Use	• Placement of the ladder • Use of ladders • Splicing together short ladders to provide longer sections prohibited
Fixed Ladders	**Requirements**
Construction	• Design loading • Design stresses • Design features • Clearance • Cages and wells • Landing platforms • Extensions • Grab bars • Safety devices • Pitch
Care	• General condition maintenance • Inspections

EXERCISE 1.24-D Using 29 CFR 1910, Subpart D, identify at least five types of scaffolds covered.

ANSWER 1.24-D Any five of the following types of scaffolds constitute the correct answer.

- Wood pole
- Tube and coupler
- Tubular welded frame
- Outrigger
- Masons' adjustable multiple-point suspension
- Two-point suspension (swinging scaffolds)
- Stone setters' adjustable multiple-point suspension
- Single-point adjustable suspension
- Boatswains' chairs
- Carpenters' bracket
- Bricklayers' square
- Horse
- Needle beam
- Plasterers', decorators', and large area
- Interior hung
- Ladder-jack
- Window-jack
- Roofing brackets
- Crawling boards or chicken ladders
- Float or ship
- Manually propelled mobile ladder stands and scaffolds
- Other working surfaces

Competency 1.25 **EH Residents shall demonstrate a working level knowledge of hazard communication (HAZCOM).**

1. Supporting Knowledge and Skills

a. Discuss the goals, actions, and employer requirements specified by the Occupational Safety and Health Administration Hazard Communication Standard.

b. Describe the purpose of a written Hazard Communication Program.

c. Describe the content and use of material safety data sheets (MSDS).

d. Describe the proper labeling requirements for hazardous material. Include the size, location, and content/description.

e. Discuss the content and use of the National Fire Protection Association Diamond for labeling hazardous material.

2. Self-Study Activities (corresponding to the intent of the above competency)

NOTE: Below are three web sites containing many of the references you may need.

Web Sites		
Organization	**Site Location**	**Notes**
Department of Energy	http://cted.inel.gov/cted/index.html	DOE Standards, Guides, and Orders.
OSHA	http://www.osha-slc.gov/	OSHA documents and search engine
U.S. House of Representatives	http://law.house.gov/cfr.htm	Searchable Code of Federal Regulations

Read 29 CFR 1910.1200 (e), Written hazard communication program.

EXERCISE 1.25-A Referring to 29 CFR 1910.1200, what are the purpose and general requirements of OSHA's hazard communication program?

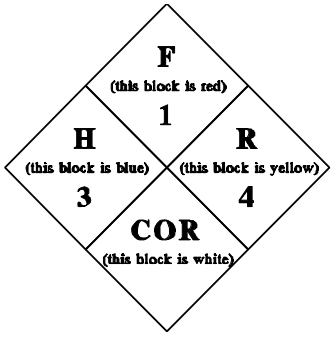
EXERCISE 1.25-B Referring to 29 CFR 1910.1200 (e), what are the purpose and general elements of an employer's written hazard communication program?

EXERCISE 1.25-C Locate and scan the material safety data sheets (MSDSs) maintained at each of the buildings or areas in which you perform your job duties. Identify the person responsible for keeping the book/file of MSDSs current. Report your findings to your supervisor.

EXERCISE 1.25-D Referring to 29 CFR 1910.1200, list and describe the sections of the material safety data sheet (MSDS)?

Read the summary section of this guide.

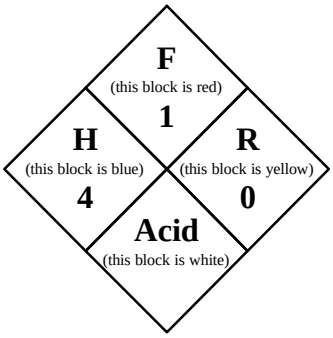
EXERCISE 1.25-E For the square containing the "R" in the following hazardous material classification sign, what does the letter and number signify?



Hazardous Material Classification

A. Radioactivity Hazard, unstable
B. Radioactivity Hazard, slightly hazardous
C. Reactivity Hazard, unstable
D. Reactivity Hazard, may detonate

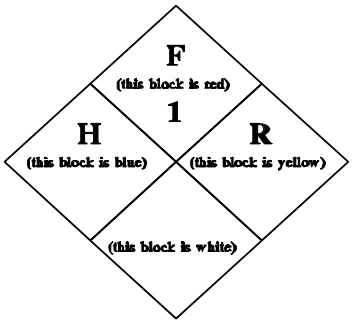
EXERCISE 1.25-F For the square containing the "H" in the following hazardous material classification sign, what do the letter and number signify?



Hazardous Material Classification

A. Health Hazard, normal
B. Health Hazard, slightly hazardous
C. Health Hazard, extremely hazardous
D. Health Hazard, deadly

EXERCISE 1.25-G For the square containing the "F" in the following hazardous material classification sign, what do the letter and number signify.



Hazardous Material Classification

A. Fire Hazard, will not burn
B. Fire Hazard, flashpoint above 220° F
C. Fission Hazard, category 1
D. Fission Hazard, criticality 1

3. Summary

MSDSs and warning labels provide guidance for working with hazardous materials. MSDSs are technical bulletins that contain specific chemical product information about the hazardous chemicals in the workplace. The MSDSs must be stored in a place accessible to the actual work area where employees may freely read or copy them. MSDSs are prepared by the manufacturer of the hazardous material and are supplied along with the procured material.

The chemical manufacturer, importer, or distributor must label each hazardous chemical container in accordance with OSHA regulations. Hazardous materials prepared for shipment must be labeled in accordance with Department of Transportation (DOT) regulations. Hazardous waste must be labeled in accordance with Environmental Protection Agency (EPA) regulations. Facilities that store or use hazardous products should have National Fire Protection Association (NFPA) warning signs.

OSHA warning labels are useful for identifying information about chemical hazards. Warning labels must the name of the chemical material that matches the name on the MSDS and all appropriate hazard warnings. Warning labels must be attached to bags, barrels, bottles, boxes, cans, cylinders, drums, reaction vessels, storage tanks, and all other chemical containers. A transfer container need not be labeled if only one person is to handle the container and the container is filled and emptied in the same work shift.

The NFPA 704 System of Hazard Identification is used to warn firefighters and emergency personnel of hazards' dangers. The NFPA 704 diamond symbol presents information on health, flammability, and reactivity hazards, as well as special hazards associated with the chemical. The numbers from 0 through 4 are placed in the three upper squares of the diamond to show the degree of hazard present for each of the three hazards (health displayed in blue, flammable in red, and reactive in yellow). Zero indicates no hazard, and four, the highest hazard. The fourth square at the bottom is used for special hazards such as oxidizer, radioactive, or to avoid the use of water. The categories for each of the hazards are:

<u>Health</u>

4 Too dangerous to enter vapor or liquid
3 Extremely dangerous - use full protective clothing
2 Hazardous - use breathing apparatus
1 Slightly hazardous
0 Like ordinary material

Flammable

4 Extremely flammable
3 Ignites at normal temperatures
2 Ignites when moderately heated
1 Must be preheated to burn
0 Will not burn

Reactive

4 May detonate - vacate area if materials are exposed to fire
3 Strong shock or heat may detonate - use monitors from behind explosion-resistant barriers
2 Violent chemical change possible - use hose streams from distance
1 Unstable if heated - use normal precautions
0 Normally stable

4. Exercise Solutions

EXERCISE 1.25-A Referring to 29 CFR 1910.1200, what are the purpose and general requirements of OSHA's hazard communication program?

ANSWER 1.25-A Purpose: To ensure that all the hazards of all chemicals produced or imported are evaluated, and that information concerning their hazards is transmitted to employers and employees.

Requirements:
1. Hazard determination
2. Written hazard communication program
3. Labels and other forms of warning
4. A material safety data sheet (MSDS) for each hazardous chemical
5. Employee information and training
6. Trade secrets

EXERCISE 1.25-B Referring to 29 CFR 1910.1200 (e), what are the purpose and general elements of an employer's written hazard communication program?

ANSWER 1.25-B Purpose: To inform and provide specific information for employees about hazardous materials in the workplace.

Elements:
1. a list of the hazardous chemicals known to be present
2. the labeling of all hazardous chemical containers
3. a material safety data sheet (MSDS) for each hazardous chemical
4. employee information and training

EXERCISE 1.25-C Locate and scan the material safety data sheets (MSDSs) maintained at each of the buildings or areas in which you perform your job duties. Identify the person responsible for keeping the book/file of MSDSs current. Report your findings to your supervisor.

ANSWER 1.25-C None required.

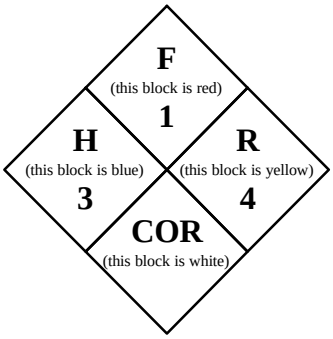
EXERCISE 1.25-D Referring to 29 CFR 1910.1200, list and describe the sections of the material safety data sheet (MSDS)?

ANSWER 1.25-D
1. Background information on the material - includes the product name/synonyms, manufacturer name and address, and the date of MSDS preparation. Also in this section are two telephone numbers: one is for use when there is an emergency situation involving the material, and the other is for obtaining additional information such as technical data.
2. Hazardous ingredients and identity information - chemical products are often mixtures of several ingredients, and the MSDS must identify all hazardous ingredients that are contained in the mixture. This section is required to list the chemical and common name of each ingredient, specify the OSHA permissible exposure limit (PEL), and specify the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV). The relative makeup by percentage of the individual items in the product is optional in this section.
3. Physical and chemical properties - includes physical and chemical properties such as boiling point, melting point, density, vapor pressure, specific gravity, water-solubility, and general appearance and odor. Such data indicate the physical state of the substance and

its reaction under certain circumstances.

4. Fire and explosion hazard data - lists special fire or explosion hazards associated with the materials. It also includes fire fighting procedures such as the best fire extinguishing and personal protective equipment. This section identifies the flash point of the material in order to indicate the minimum temperature at which the substance will give off sufficient vapor to support combustion. Also included is the amount of gas/vapor of the substance, by volume in air, that will explode or burn if ignited.
5. Reactivity data - indicates the stability of the chemical and identifies incompatible materials and conditions to avoid. Hazardous decomposition by-products are listed only if the material is at risk of decomposition. If a chemical has a tendency to polymerize, any associated hazards are also listed in this section. Polymerization is the process by which chemicals self-react and combine to form larger molecules.
6. Health hazard data - includes a list of overexposure indicators and routes of entry. This section also lists exiting medical conditions that are aggravated by exposure to the material. For each route of entry there must be a list of immediate (acute) health effects, delayed (chronic) health effects, emergency and first-aid procedures, and exposure limits (for airborne hazards).
7. Precautions for safe handling and use - involves instructions for storage, containment, recovery, and disposal. The handling and storage portion may provide information such as temperature ranges, humidity ranges, and other climatic information. Special requirements for transportation should also be listed here.
8. Control measures - details control measures, especially personal protective equipment. Included here are appropriate cartridges for respirators, specific materials for gloves and protective clothing, and necessary eye and face protection. The level of ventilation required is also listed.

EXERCISE 1.25-E For the square containing the "R" in the following hazardous material classification sign, what do the letter and number signify?

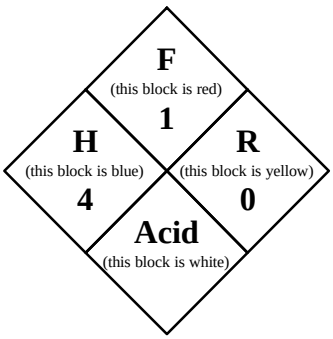


Hazardous Material Classification

A. Radioactivity Hazard, unstable
B. Radioactivity Hazard, slightly hazardous
C. Reactivity Hazard, unstable
D. Reactivity Hazard, may detonate

ANSWER 1.25-E D. Reactivity Hazard, may detonate. Evacuate area if materials are involved in fire.

EXERCISE 1.25-F For the square containing the "H" in the following hazardous material classification sign, what do the letter and number signify?

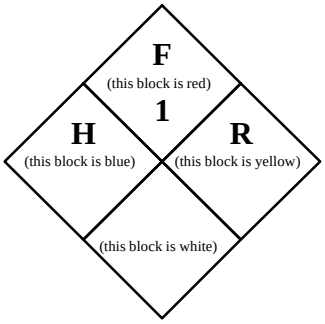


Hazardous Material Classification

A. Health Hazard, normal
B. Health Hazard, slightly hazardous
C. Health Hazard, extremely hazardous
D. Health Hazard, deadly

ANSWER 1.25-F D. Health Hazard, deadly

EXERCISE 1.25-G For the square containing the "F" in the following hazardous material classification sign, what do the letter and number signify.



Hazardous Material Classification

A. Fire Hazard, will not burn
B. Fire Hazard, flashpoint above 220° F
C. Fission Hazard, category 1
D. Fission Hazard, criticality 1

ANSWER 1.25-G B. Fire Hazard, flashpoint above 220° F

Competency 1.26 **EH residents shall demonstrate a working level knowledge of electrical safety.**

1. Supporting Knowledge and Skills

a. Discuss the different requirements for operation and worker qualifications for high versus low voltage. Include procedural differences such as resetting trips.

b. Describe the following elements of safe work practices for electrical workers:
- Work planning
- Work package, including procedures
- Personal protective equipment
- Training/qualification

c. Given a piece of electrical equipment, discuss the potential sources of shock hazards, the degree of the hazard associated with different equipment, and preventive measures required.

d. Discuss the potential severity of an electrical shock based on the current flow, current path, and the circuit interrupt speed of any overcurrent or ground fault devices in the circuit.

e. Describe the difference between equipment grounding, system grounding, and grounding.

f. Describe the purpose and operation of a ground fault circuit interrupter (GFCI).

2. Self-Study Activities (corresponding to the intent of the above competency)

NOTE: Below are three web sites containing many of the references you may need.

Web Sites		
Organization	**Site Location**	**Notes**
Department of Energy	http://cted.inel.gov/cted/index.html	DOE Standards, Guides, and Orders.
OSHA	http://www.osha-slc.gov/	OSHA documents and search engine
U.S. House of Representatives	http://law.house.gov/cfr.htm	Searchable Code of Federal Regulations

Read 29 CFR 1910.332, "Training" of Subpart S, [illegible]

EXERCISE 1.26-A Referring to 29 CFR 1910.332, summarize the training requirements.

Read DOE/ID-10600, [illegible] Section 2.9, "Working Space Around Electrical Equipment."

EXERCISE 1.26-B Discuss the different requirements for equipment operation for high versus low voltage.

Read DOE/ID-10600, [illegible] Section 2.11, "Work Procedures," and Section 2.12, "Electrical Protective Clothing and Equipment."

EXERCISE 1.26-C Describe the following elements of safe work practices for electrical workers:

- Work planning
- Work package, including procedures
- Personal protective equipment
- Training/qualification

Read Department of Energy: [illegible] Section 2.9, "Working Space Around Electrical Equipment."

EXERCISE 1.26-D Why are minimum distance requirements established for both low and high voltage systems?

EXERCISE 1.26-E In your workspace, a control panel for an electrical distribution system for the facility is to be installed. Voltages in the system are between 600 volts and 25,000 volts. The wall closest to where the panel is to be installed is a grounded wall constructed of concrete. Using NEC Table 110-34/OSHA Table S-2 located in Section 2.9.2, determine the "condition" that applies.

EXERCISE 1.26-F Using NEC Table 110-34/OSHA Table S-2, and the minimum distances for condition 2, determine the minimum distance the control panel must be from the wall.

Read Department of Energy: Appendix A: "Understanding Electrical Safety," A-4, A-5.

EXERCISE 1.26-G Discuss the potential severity of an electrical shock based on the current flow, current path, and the circuit interrupt speed of any overcurrent or ground fault devices in the circuit.

Read Department of Energy: Section 4: "Grounding."

EXERCISE 1.26-H Describe the difference between equipment grounding, system grounding, and grounding.

Read Department of Energy: Section 8: "Temporary Wiring," Item 8.2, Ground Fault Circuit Interrupters.

EXERCISE 1.26-I Describe the purpose and operation of a ground fault circuit interrupter (GFCI).

3. Summary

Identification and acknowledgment of electrical hazards in the workplace is the first step in developing an electrical safety program. Once identified, precautions must be put into place to prevent electric shock to the worker. Precautions include design factors for equipment or spaces, or personal protective equipment that ranges from rubber gloves and mats (blankets) to the tools used. All must be considered when analyzing an electrical safety program. For more information, refer to the prepared by the Oak Ridge Operations Office for the U.S. Department of Energy.

4. Exercise Solutions

EXERCISE 1.26-A Referring to 29 CFR 1910.332, summarize the training requirements.

ANSWER 1.26-A Below is a summary of training requirements found in 29 CFR 1910.332, "Training" of Subpart S,

- The training requirements apply to employees who face a risk of electric shock that is not reduced to a safe level by the electrical installation requirements of 1910.303 through 1910.308.

- Employees who face such a risk are required to be trained. The CFR targets occupations requiring training in Table S-4. Other employees who also may reasonably be expected to face a comparable risk of injury due to electric shock or other electrical hazards must also be trained.
- Qualified persons (i.e. those permitted to work on or near exposed energized parts) shall, at a minimum, be trained in and familiar with the following:
  - The skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment
  - The skills and techniques necessary to determine the nominal voltage of exposed live parts
  - The clearance distances specified in 1910.333(c) and the corresponding voltages to which the qualified person will be exposed.
- The degree of training provided depends on the risk to the employee.

EXERCISE 1.26-B Discuss the different requirements for equipment operation for high versus low voltage.

ANSWER 1.26-B For low voltage (<600 volts), a working space with a minimum width of 30 inches and a depth of 3, 3 ½, or 4 feet, depending on conditions, is required.

For high voltage (>600 volts), minimum clearances of 3-10 feet are required, depending on the conditions.

EXERCISE 1.26-C Describe the following elements of safe work practices for electrical workers:
- Work planning
- Work package, including procedures
- Personal protective equipment
- Training/qualification

ANSWER 1.26-C Before work is begun, the qualified worker shall ensure that the job to be done is in compliance with written procedures pertaining to electrical work. Electrical work shall be performed according to written safety procedures and approved electrical safety guidelines or manuals. Electrical work shall be directed by a supervisor, qualified by training in safety-related work practices that pertain to his/her

respective job assignments and those of his/her employees.

Qualified workers are responsible for avoiding and preventing accidents while performing electrical work. Personnel shall wear or use protective clothing or equipment that is approved for safe performance of work.

EXERCISE 1.26-D Why are minimum distance requirements established for both low and high voltage systems?

ANSWER 1.26-D To allow for sufficient space between the voltage source and the nearest conductor or ground in the event that the worker should make contact with live components. It ensures that the worker cannot touch both the source and the ground simultaneously.

EXERCISE 1.26-E In your workspace, a control panel for an electrical distribution system for the facility is to be installed. Voltages in the system are between 600 volts and 25,000 volts. The wall closest to where the panel is to be installed is a grounded wall constructed of concrete. Using NEC Table 110-34/OSHA Table S-2 located in Section 2.9.2, determine the "condition" that applies.

ANSWER 1.26-E Condition 2 states "where there are exposed live components on one side and grounded parts on the other such as concrete, brick, and tile walls that are considered to be grounded parts."

EXERCISE 1.26-F Using NEC Table 110-34/OSHA Table S-2, and the minimum distances for condition 2, determine the minimum distance the control panel must be from the wall.

ANSWER 1.26-F The minimum distance for equipment in the voltage and the "condition" is 6 feet.

EXERCISE 1.26-G Discuss the potential severity of an electrical shock based on the current flow, current path, and the circuit interrupt speed of any overcurrent or ground fault devices in the circuit.

ANSWER 1.26-G From Figure A-4, one can determine that a 100 mA current flowing for three seconds through a human adult body will cause death by electrocution. It is imperative that all electrical equipment be connected

to a properly wired circuit with an equipment grounding conductor (EGC).

EXERCISE 1.26-H Describe the difference between equipment grounding, system grounding, and grounding.

ANSWER 1.26-H Grounding is used to give proper protection of such systems in order to safely clear the phase-to-ground faults that can occur.

Circuit and system grounding consist of connecting the grounded conductor, the equipment grounding conductor, the grounding bus bar, and all metal enclosures to ground. This is accomplished by connecting a properly sized, unspliced grounding electrode conductor between the grounding busbar and the grounding electrode system. There are three fundamental purposes for grounding an electrical system:

1. To limit excessive voltage from lightning, line surges, and crossovers with higher voltage lines.
2. To keep conductor enclosures and noncurrent-carrying metal enclosures and equipment at zero potential to ground.
3. To facilitate the opening of overcurrent protection devices in case of insulation failures.

Equipment grounding systems, which consist of interconnected networks of equipment grounding conductors, are utilized to perform the following functions:

1. Limit the voltage to ground (shock voltage) on the exposed noncurrent-carrying metal parts of equipment raceways and other conductor enclosures in case of ground faults.
2. Safely conduct ground fault current at sufficient magnitude for fast operation of the circuit overcurrent protection devices.

EXERCISE 1.26-I Describe the purpose and operation of a ground fault circuit interrupter (GFCI).

ANSWER 1.26-I GFCIs are devices that sense when current - even a small amount - passes to ground through any other path than the proper conductor. When this condition exists, the GFCI quickly opens the circuit, stopping all current flow to the circuit and to the person receiving the ground fault shock

Competency 1.29 **EH residents shall demonstrate a familiarity level knowledge of safety in specialized construction activities.**

1. Supporting Knowledge and Skills

a. Describe the hazards and protective systems and how they apply to the following areas associated with trenching and excavation:
- Soil characterizations
- Shoring
- Access
- Confined space

b. Describe the special safety considerations for the following activities involved in steel erection.
- Elevated work/fall protection
- Material handling equipment
- Rigging applications
- Load paths

c. Discuss the safety requirements for construction activities involving concrete and masonry. Include construction of forms and handling of equipment.

2. Self-Study Activities (corresponding to the intent of the above competency)

NOTE: Below are three web sites containing many of the references you may need.

Web Sites		
Organization	**Site Location**	**Notes**
Department of Energy	http://cted.inel.gov/cted/index.html	DOE Standards, Guides, and Orders.
OSHA	http://www.osha-slc.gov/	OSHA documents and search engine
U.S. House of Representatives	http://law.house.gov/cfr.htm	Searchable Code of Federal Regulations

Scan 29 CFR 1926, Subpart P, [illegible]

Scan OSHA 2202, [illegible]

EXERCISE 1.29-A Referring to 29 CFR 1926, Subpart P, [illegible] describe: (1) the factors affecting soil stability in a trench and (2) the protective shoring systems applied when a hazard is identified.

EXERCISE 1.29-B With regard to excavations, describe the characteristics of a confined space.

EXERCISE 1.29-C Define "limited access zone" as it relates to construction activities.

EXERCISE 1.29-D Referring to 29 CFR 1926, Subpart P, [illegible] discuss the general safety precautions taken to enter or limit access to an excavation.

Review 29 CFR 1926.105, "Safety Nets."

NOTE: This Standard applies only to steel erection activity.

Review OSHA 2202, Construction Industry Standards.

EXERCISE 1.29-E Referring to 29 CFR 1926.105, "Safety Nets," when should safety nets be provided?

EXERCISE 1.29-F Referring to 29 CFR 1926.105, "Safety Nets," how far out should safety nets extend beyond the edge of the work surface?

Read 29 CFR 1910, Subpart N, "Materials Handling and Storage."

Read 29 CFR 1910.179, [illegible]

Review DOE/ID-10500, [illegible]

EXERCISE 1.29-G Referring to 29 CFR 1910.179, [illegible] describe the safety hazards associated with crane and gantry operation during material handling and storage activities.

EXERCISE 1.29-H Describe the purpose of the load rating for a crane.

Read 29 CFR 1926 Subpart Q, [illegible]

Scan OSHA 2202, [illegible]

EXERCISE 1.29-I Referring to 29 CFR 1926 Subpart Q, [illegible] what are the requirements for constructing forms?

EXERCISE 1.29-J Referring to OSHA 2202, [illegible] what are the basic requirements for concrete and masonry construction?

3. Summary

Specialized construction activities including trenching and excavation, steel erection, and concrete and masonry all require compliance with OSHA regulations. Although compliance with the law, including specific OSHA standards, is an important objective, an effective program looks beyond specific requirements of law to address all hazards. It will seek to prevent injuries and illnesses, whether or not compliance is at issue. The extent to which the program is described in writing is less important than how effective it is in practice. As the size of a worksite or the complexity of a hazardous operation increases, however, the need for written guidance increases to ensure clear communication of policies and priorities as well as a consistent and fair application of rules. DOE must comply to protect construction workers from accidents and injuries resulting from the premature removal of formwork, the failure to brace masonry walls, the failure to support precast panels, the inadvertent operation of equipment, and the failure to guard reinforcing steel.

4. Exercise Solutions

EXERCISE 1.29-A Referring to 29 CFR 1926, Subpart P, describe: (1) the factors affecting soil stability in a trench and (2) the protective shoring systems applied when a hazard is identified.

ANSWER 1.29-A There are a number of factors that affect soil stability in a trench. Some of the more common factors include the following:

- Nearby traffic
- Nearness of structures
- Condition of nearby structures
- Soil type (density, makeup)

- Surface and ground water (rain, runoff, water table)
- Overhead and underground utilities
- Weather

In 29 CFR 1926, Subpart P, "Excavations,"OSHA requires that, in all excavations, employees exposed to potential cave-ins must be protected by sloping, or benching the sides of the excavation; supporting the sides of the excavation; or placing a shield between the side of the excavation and the work area.

In general, 29 CFR 1926, Subpart P, "Excavations," requires that a competent person inspect the following on a daily basis:

- excavations and the adjacent areas for possible cave-ins
- failures of protective systems and equipment
- hazardous atmospheres, or other hazardous conditions

If these conditions are encountered, OSHA requires exposed employees to be removed from the hazardous area until the necessary safety precautions have been taken. Inspections are also required after natural (e.g., heavy rains) or man-made events such as blasting that may increase the potential for hazards.

EXERCISE 1.29-B With regard to excavations, describe the characteristics of a confined space.

ANSWER 1.29-B A confined space has one or more of the following characteristics:

- Contains or has a potential to contain a hazardous atmosphere
- Contains a material that has the potential for engulfing an entrant
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross-section
- Contains any other recognized serious safety or health hazard

EXERCISE 1.29-C Define "limited access zone" as it relates to construction activities.

ANSWER 1.29-C A limited access zone is an area that is under construction and is clearly demarcated to limit access by employees.

EXERCISE 1.29-D Referring to 29 CFR 1926, Subpart P, "Excavations," discuss the general safety precautions taken to enter or limit access to an excavation.

ANSWER 1.29-D The following general safety precautions apply to confined spaces:

Note: Each facility may add additional requirements depending on site-specific hazards.

- Complete a confined space entry permit.
- Confirm or perform training to establish personnel proficiency in the duties required.
- Test the atmosphere.
- Set up atmospheric monitoring to be performed throughout the entry. If a hazardous atmosphere is detected, evaluate to determine the cause.
- Take measures to protect employees before entry is made.
- Require proper respiratory equipment if needed.
- Allow entry only after all requirements of the permit are met and it is reviewed and signed by the entry supervisor or job leader.

EXERCISE 1.29-E Referring to 29 CFR 1926.105, "Safety Nets," when should safety nets be provided?

ANSWER 1.29-E Safety nets shall be provided when workplaces are more than 25 feet above the ground or water surface or other surfaces where the use of ladders, scaffolds, catch platforms, temporary floors, safety wires, or safety belts is impractical.

EXERCISE 1.29-F Referring to 29 CFR 1926.105, "Safety Nets," how far out should safety nets extend beyond the edge of the work surface?

ANSWER 1.29-F Nets shall extend 8 feet beyond the edge of the work surface.

EXERCISE 1.29-G Referring to 29 CFR 1910.179, describe the safety hazards associated with crane and gantry operation during material handling and storage activities.

ANSWER 1.29-G Serious hazards are overloading, dropping or slipping of the load caused by improper hitching or slinging, obstruction to the free passage of the load, or using equipment for a purpose for which it was not intended or designed." DOE/ID-10500, [illegible]2.1
"Operator Training."

EXERCISE 1.29-H Describe the purpose of the load rating for a crane.

ANSWER 1.29-H Each crane is required to have a rated capacity marked on the side of the crane to provide the operator with the information necessary for safe operation. The load rating provides the maximum working load allowed for the crane. A crane may not be loaded beyond its rated capacity except for test purposes.

EXERCISE 1.29-I Referring to 29 CFR 1926, Subpart Q, "Concrete and Masonry Construction," what are the requirements for constructing forms?

ANSWER 1.29-I 29 CFR 1926.703, Requirements for cast-in-place concrete(c)(ii)(2 - 7), states:
"(2) Forms shall be designed to prevent excessive distortion of the structure during the jacking operation.
(3) All vertical slip forms shall be provided with scaffolds or work platforms where employees are required to work or pass.
(4) Jacks and vertical supports shall be positioned in such a manner that the loads do not exceed the rated capacity of the jacks.
(5) The jacks or other lifting devices shall be provided with mechanical dogs or other automatic holding devices to support the slip forms whenever failure of the power supply or lifting mechanism occurs.
(6) The form structure shall be maintained within all design tolerances specified for plumbness during the jacking operation.
(7) The predetermined safe rate of lift shall not be exceeded."

EXERCISE 1.29-J Referring to OSHA 2202, what are the basic requirements for concrete and masonry construction?

ANSWER 1.29-J OSHA 2202 states the following general requirements about concrete and masonry construction:

a. No construction loads shall be placed on a concrete structure or portion of a concrete structure unless the employer determines, based on information received from a person who is qualified in structural design, that the structure or portion of the structure is capable of supporting the loads.
b. All protruding reinforcing steel, onto and into which employees could fall, shall be guarded to eliminate the hazard of impalement.
c. No employee shall be permitted to work under concrete buckets while buckets are being elevated or lowered into position.
d. To the extent practical, elevated concrete buckets shall be routed so that no employee, or the fewest number of employees, are exposed to the hazards associated with falling concrete buckets.
e. Formwork shall be designed, fabricated, erected, supported, braced, and maintained so that it will be capable of supporting without failure all vertical and lateral loads that may reasonably be anticipated to be applied to the formwork.
f. Forms and shores (except those used for slabs on grade and slip forms) shall not be removed until the employer determines that the concrete has gained sufficient strength to support its weight and superimposed loads. Such determination shall be based on compliance with one of the following:
    1. The plans and specifications stipulate conditions for removal of forms and shores, and such conditions have been followed, or
    2. The concrete has been properly tested with an appropriate American Society for Testing Materials (ASTM) standard test method designed to indicate the concrete compressive strength, and the test results indicate that the concrete has gained sufficient strength to support its weight and superimposed loads.

Competency 2.8 **EH residents shall demonstrate a familiarity level knowledge of the requirements for occupational safety and health in the following Department of Energy (DOE) Orders:**

- **DOE Order 5480.8A, Contractor Occupational Medical Program**
- **DOE Order 5480.9A, Construction Safety and Health Program**
- **DOE Order 5480.10, Contractor Industrial Hygiene Program**
- **DOE Order 5483.1A, Occupational Safety and Health Program for DOE Employees at Government-Owned Contractor-Operated Facilities**

1. Supporting Knowledge and Skills

a. Discuss the purpose and scope of the Orders listed above.

b. Discuss the applicability and impact of the above listed Orders on the EH oversight program.

c. Describe the authorities and responsibilities of the EH resident with respect to the Orders listed above.

NOTE: DOE Order 5480.8A, 5480.9A, 5480.10, and 5483.1A have been canceled by DOE Order 440.1, *[illegible]*

2. Self-Study Activities (corresponding to the intent of the above competency)

NOTES:
- The DOE Orders are in a state of transition. Please refer to the following gopher site for a cross reference of new and old Orders: gopher://VM1.HQADMIN.DOE.GOV:70/00/doemenu1/directiv/251cross.asc
- Below are three web sites containing many of the references you may need.

Web Sites		
Organization	**Site Location**	**Notes**
Department of Energy	http://cted.inel.gov/cted/index.html	DOE Standards, Guides, and Orders.
OSHA	http://www.osha-slc.gov/	OSHA documents and search engine
U.S. House of Representatives	http://law.house.gov/cfr.htm	Searchable Code of Federal Regulations

Scan the listed Orders:

- DOE Order 5480.8A,
- DOE Order 5480.9A,
- DOE Order 5480.10,
- DOE Order 5483.1A,

EXERCISE 2.8-A Discuss the purpose and scope of the Orders listed above.

EXERCISE 2.8-B Discuss the applicability and impact of the listed Orders on the EH oversight program:

- DOE Order 5480.8A,
- DOE Order 5480.9A,
- DOE Order 5480.10,
- DOE Order 5483.1A,

3. Summary

With the implementation of the Occupational Safety and Health Act of 1970 for private industry, federal departments and offices were exempted. Orders were issued to establish the programs specifically for DOE and its contractors. The Orders listed establish a contractor occupational medical program, a construction safety and health program, a contractor industrial hygiene program, and an occupational safety and health program for Government-Owned, Contractor-Operated (GOCO) Facilities.

4. Exercise Solutions

EXERCISE 2.8-A Discuss the purpose, scope of the Orders listed above.

EXERCISE 2.8-B Discuss the applicability and impact of the listed Orders on the EH oversight program:

- DOE Order 5480.8A,
- DOE Order 5480.9A,
- DOE Order 5480.10,
- DOE Order 5483.1A,

ANSWER 2.8-A and B

Selected Occupational Safety and Health Orders: Purpose and Scope			
Order	**Purpose**	**Scope/Applicability**	**Impact**
5480.8A	To establish the minimum occupational medical program requirements for DOE.	Scope: The provisions of this Order apply to all Departmental elements and contractors performing work for the Department as provided by law and/or contract and as implemented by the appropriate contracting officer. Applicability: The provisions of this Order apply to all Departmental elements and contractors performing work for the Department as provided by law and/or contract and as implemented by the appropriate contracting officer.	Assessments will have to include the contractor occupational medical program for contracts that are within the scope of this Order.
5480.9A	To establish specific requirements for the management of occupational safety and health (OSH) on DOE construction projects.	Scope: The provisions of this Order apply to all Departmental elements and, to the extent provided in their contracts/ subcontracts, to contractors and subcontractors performing work on DOE construction projects that exceed the monetary threshold (currently $2,000) for application of the wage standards prescribed by the Davis-Bacon Act (40 U.S.C. 276a-276a-7). Applicability: The requirements of this Order shall apply to contracts at government-owned or -leased facilities upon which the contract clause "Safety and Health (Government-owned or -leased Facility)" (DEAR 970.5204-2) applies.	Contractor assessments will have to include the contractor safety and health program for contracts that are within the scope of this Order.

Selected Occupational Safety and Health Orders: Purpose and Scope			
Order	**Purpose**	**Scope/Applicability**	**Impact**
5480.10	To establish the requirements and guidelines applicable to DOE contractor operations for maintaining an effective industrial hygiene program to preserve employee health and well-being.	Scope: The provisions of this Order apply to all Departmental elements and to contractors performing work for the Department as provided by law and/or contract and as implemented by the appropriate contracting officer. Applicability: The Order lists the responsibilities and authorities of Departmental elements for policy development and overview of industrial hygiene programs at government-owned, contractor-operated (GOCO) facilities. The industrial hygiene program elements contained in this Order apply to contractor organizations performing the actual work or job-related tasks and whose contracts include the occupational safety and health contract clause specified in DOE Acquisition Regulation, 48 CFR 970.520401, "Safety and Health." The program elements do not apply to control of occupational exposure to ionizing radiation.	Contractor assessments will have to include the contractor industrial hygiene program for contracts that are within the scope of this Order.

Selected Occupational Safety and Health Orders: Purpose and Scope			
Order	**Purpose**	**Scope/Applicability**	**Impact**
5483.1A	To establish requirements and procedures to assure that occupational safety and health standards prescribed pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, provide occupational safety and health protection for DOE contractor employees in government-owned contractor-operated (GOCO) facilities that is consistent with the protection afforded private industry employees by the occupational safety and health standards promulgated under the Occupational Safety and Health Act of 1970 (OSHA), Public Law 91-596.	Scope: The provisions of this Order apply to all elements of DOE and to DOE contractors whose contracts include the occupational safety and health contract clause specified in DOE Procurement Regulation (PR) 9-50.704-2(a). The provisions of this Order apply only with respect to radiation hazards in the workplace to DOE contractors whose contracts include the radiation protection contract clause specified in DOE PR 9-50.704-2 (b). Applicability: To provide occupational safety and health protection for DOE contractor employees in government-owned, contractor-operated (GOCO) facilities that is consistent with the protection afforded private industry employees by the occupational safety and health standards promulgated under the Occupational Safety and Health Act of 1970 (OSHA), Public Law 91-596.	Contractor assessments will have to include the contractor occupational safety and health program for contracts that are within the scope of this Order.

Competency 2.18 **EH residents shall demonstrate the ability to evaluate hazardous energy control programs in accordance with the following regulation and Department of Energy (DOE) Order:**

- **29 CFR 1910.147, Hazardous Energy Control**
- **DOE Order 5480.19, Conduct of Operations Requirements for DOE Facilities**

1. Supporting Knowledge and Skills

a. Using the appropriate standard(s), identify the markings and guards required for a specific piece of electrical equipment.

b. Describe the requirements and verify that the contractor's lockout/tagout program adequately addresses the following areas:
- Use of lockout/tagout
- Adequacy of procedures
- Verification of lockout/tagout
- Reenergizing equipment
- Protection from shock/equipment start
- Surveillance of the lockout/tagout program
- Initial and annual training requirements

c. Verify the specialized personal protective equipment and adequacy of worker qualifications for an activity involving hazardous energy.

d. Identify one type of each of the following hazardous energy sources at your site:
- Electrical
- Mechanical
- Pneumatic
- Hydraulic
- Thermal
- Chemical
- Radiation

e. Given a hazardous energy source, describe the lockout/tagout requirements.

f. Differentiate between the lockout/tagout requirements for the following:
   - Personnel protection
   - Equipment protection
   - Operations
   - Administrative
   - Confined space

g. Define independent verification and discuss when independent verification is required.

h. Given a lockout/tagout for a hazardous energy source, verify that the lockout/tagout adequately isolates the hazardous energy source.

2. Self-Study Activities (corresponding to the intent of the above competency)

NOTE: Below are three web sites containing many of the references you may need.

Web Sites		
Organization	**Site Location**	**Notes**
Department of Energy	http://cted.inel.gov/cted/index.html	DOE Standards, Guides, and Orders.
OSHA	http://www.osha-slc.gov/	OSHA documents and search engine
U.S. House of Representatives	http://law.house.gov/cfr.htm	Searchable Code of Federal Regulations

Read 29 CFR 1910.147, "The Control of Hazardous Energy (Lockout/Tagout);" DOE-STD-1030-92, sections 4.2 and 4.4; and DOE Order 5480.19, Attachment 1, chapter IX, Lockouts and Tagouts

EXERCISE 2.18-A Use the process matrix provided below to identify the markings and guards (i.e., the lockout/tagouts) required for a motor control center (MCC).

NOTE: The actions and steps listed in the matrix should work for any electrical equipment. Apply it to other devices as appropriate.

Application of Control for a Motor Control Center (MCC)			
Action		**Steps**	**Specific Markings and Guards (Lockouts/Tagouts) for MCC**
1	Preparation for shutdown	• Identify the type and magnitude of the energy • Identify the hazards of the energy to be controlled • Identify the method or means to control the energy	Energy type: Magnitude: Energy hazards: Control methods or means:
2	Machine or equipment shutdown	List the turn off or shut down procedures established for the machine or equipment	Shutdown procedures:
3	Machine or equipment isolation	• Physically locate all energy isolating devices that are needed to control the energy to the machine or equipment • operate so as to isolate the machine or equipment from the energy source(es)	Location of energy isolating devices: Isolation operating procedure:
4	Lockout or tagout device application	Affix lockout or tagout device to each energy isolating device	Lockout used: Tagout used:
5	Stored energy	Render safe all potentially hazardous stored or residual energy by relieving, disconnecting, restraining, or other method	Method for rendering safe all stored or residual energy:

Application of Control for a Motor Control Center (MCC)			
Action		**Steps**	**Specific Markings and Guards (Lockouts/Tagouts) for MCC**
6	Verification of isolation	Prior to starting work on locked out/tagged out machines or equipment, verify that isolation and deenergization of the machine or equipment	Isolation and deenergization indicators:

Scan DOE Order 5480.19, [redacted]
Attachment I.

EXERCISE 2.18-B Complete the following table, citing the DOE Order 5480.19 requirements and references for the following.

Contractor Lockout/Tagout Requirements		
Title	**Required**	**DOE Order 5480.19 Reference**
Use of lockout/tagout		
Adequacy of procedures		
Verification		
Reenergizing equipment		
Protection-shock/equipment start		
Surveillance		
Initial/Annual Training Requirement		

For the following exercise, refer to facility-specific/local procedures and 29 CFR 1910 as needed.

EXERCISE 2.18-C Verify the specialized personal protective equipment (PPE) and adequacy of worker qualifications for an activity involving

hazardous energy at your facility.

Example:

Activity	Specialized PPE	Worker Qualifications
Work inside a 220 V distribution box	Insulated tools, goggles, rubber gloves, rubber mat	Only a worker trained in those procedures (or a worker in training and under the direct supervision of a qualified worker) may work on power-on equipment.

EXERCISE 2.18-D Using the table below, identify one type of each of the following hazardous energy sources that apply to your site.

Hazardous Energy Sources		
Hazardous Energy	**Example**	**Location**
Electrical	Distribution box	Room 271-4A west wall
Electrical		
Mechanical		
Pneumatic		
Hydraulic		
Thermal		
Chemical		
Radiation		

EXERCISE 2.18-E Given a hazardous energy source at your site(s), describe the lockout/tagout requirements.

The answer is site-specific and dependent on the equipment selected. However, for a particular hazardous energy source, the following checklist can be used to verify what is

required for the lockout/tagout program/procedures.

Lockout/Tagout Requirements			
Title	**Required**	**Contractor Program Checklist**	
		Yes	**No**
Use of lockout/tagout	Locks and tags should be placed on controls when for safety or other administrative reasons controls must be established.		
Adequacy of procedures	Procedures should be developed, documented, validated, and utilized for hazardous energy or material.		
Verification	Personnel should verify that isolation and deenergization has been accomplished.		
Reenergizing equipment	Before energy is restored, procedures followed and actions taken.		
Protection-shock/equipment start	All personnel positioned or safely removed from the area.		
Surveillance	Periodic inspections should be conducted by authorized personnel.		
Initial/Annual Training Requirement.	Training should be provided and documented.		

NOTE: The checklist is based on the requirements of DOE Order 5480.19 and 29 CFR 1910.147.

EXERCISE 2.18-F To differentiate between the following terms, complete the table below.

Lockout/Tagout Terminology	
Term	**Definition**
Personnel protection	
Equipment protection	
Operations	
Administrative	
Confined space	

Read DOE Order 5480.19, [redacted]
Attachment 1, Chapter X, "Independent Verification."

EXERCISE 2.18-G Define independent verification.

EXERCISE 2.18-H Discuss when independent verification is required

Read 29 CFR 1910.147, [redacted](3) "Purpose."

Given the following scenario, determine the steps needed to verify that the lockout/tagout effectively isolates the energy source.

EXERCISE 2.18-I Scenario: An overhead light socket has burned out due to dust, condensation, and/or age. The light is turned off/on by a wall switch. A repairman is coming in to replace the socket. Assuming that a lockout/tagout program is in place, where must the lockout/tagout device be placed to effectively isolate the socket from the energy source and what additional checks should be made to verify that the isolation is effective?

3. Summary

DOE Order 5480.19, [redacted] and 29 CFR 1910.147 set the general requirements for lockout/tagout programs and procedures and the requirements for training all personnel. The actual requirements will vary depending upon the specific site or facility, the types of equipment in a particular facility, and the hazardous energy sources.

A lockout/tagout program is used to ensure that equipment is not inadvertently started when it is not intended to start and to ensure that any stored energy does not injure personnel. Lockouts and tagouts must be strictly adhered to in order for the system or program to be effective. Ignoring a lockout/tagout can injure not only the person that ignores it but other personnel and equipment.

The training requirements state that the employer shall provide training to ensure that the purpose and function of the energy control program is understood by all employees and that the knowledge and skills required for safe application, usage, and removal of the energy controls are acquired by employees. Each affected employee shall be instructed in the purpose and use of the energy control procedure and all other employees whose work operations are or may be in an area where energy control procedures may be utilized, shall be instructed about the procedure and the prohibition relating to attempts to restart or reenergize machines or equipment that are locked out or tagged out.

4. Exercise Solutions

EXERCISE 2.18-A Use the process matrix provided below to identify the markings and guards (i.e., the lockout/tagouts) required for a motor control center (MCC).

ANSWER 2.18-A NOTE: The actions and steps listed in the matrix should work for any electrical equipment. Apply it to other devices as appropriate.

Application of Control for a Motor Control Center (MCC)			
Action		**Steps**	**Specific Markings and Guards (Lockouts/Tagouts) for MCC**
1	Preparation for shutdown	• Identify the type and magnitude of the energy • Identify the hazards of the energy to be controlled • Identify the method or means to control the energy	Energy type: Magnitude: Energy hazards: Control methods or means:
2	Machine or equipment shutdown	List the turn off or shut down procedures established for the machine or equipment	Shutdown procedures:

Application of Control for a Motor Control Center (MCC)			
Action		**Steps**	**Specific Markings and Guards (Lockouts/Tagouts) for MCC**
3	Machine or equipment isolation	• Physically locate all energy isolating devices that are needed to control the energy to the machine or equipment • operate so as to isolate the machine or equipment from the energy source(es)	Location of energy isolating devices: [redacted] Isolation operating procedure: [redacted]
4	Lockout or tagout device application	Affix lockout or tagout device to each energy isolating device	Lockout used: [redacted] Tagout used: [redacted]
5	Stored energy	Render safe all potentially hazardous stored or residual energy by relieving, disconnecting, restraining, or other method	Method for rendering safe all stored or residual energy: [redacted]
6	Verification of isolation	Prior to starting work on locked out/tagged out machines or equipment, verify that isolation and deenergization of the machine or equipment	Isolation and deenergization indicators: • [redacted] • [redacted]

EXERCISE 2.18-B Complete the following table, citing the DOE Order 5480.19 requirements and references for the following.

ANSWER 2.18-B

Contractor Lockout/Tagout Requirements		
Title	**Required**	**DOE Order 5480.19 Reference**
Use of lockout/tagout	Locks and tags should be placed on controls when for safety or other administrative reasons controls must be established.	Chap. IX, Section C.1. Lockout/Tagout Use
Adequacy of procedures	Procedures should be developed, documented, validated, and utilized for hazardous energy or material.	Chap. IX, Section C.5., Procedures
Verification	Personnel should verify that isolation and deenergization has been accomplished.	Chap. IX, Section C.6.f., Verification
Reenergizing equipment	Before energy is restored, procedures followed, and actions taken.	Chap. IX, Section C.6.g., Release from lockout/tagout
Protection-shock/equipment start	All personnel positioned or safely removed from the area.	Chap. IX, Section C.6.g.(2), Personnel
Surveillance	Periodic inspections should be conducted by authorized personnel.	Chap. IX, Section C.8., Inspections
Initial/Annual Training Requirement	Training should be provided and documented.	Chap. IX, Section C.10., Training and Communication

EXERCISE 2.18-C Verify the specialized personal protective equipment (PPE) and adequacy of worker qualifications for an activity involving hazardous energy at your facility.

ANSWER 2.18-C The answer is site-specific. Please refer to a local subject matter expert to verify your answers.

EXERCISE 2.18-D Using the table below, identify one type of each of the following hazardous energy sources at your site.

ANSWER 2.18-D The answer is site-specific. Please refer to a local subject matter expert to verify your answers.

EXERCISE 2.18-E Given a hazardous energy source at your site(s), describe the lockout/tagout requirements.

ANSWER 2.18-E The answer is site-specific and dependent on the equipment selected. However, for a particular hazardous energy source, the checklist provided in the exercise can be used to verify what is required for the lockout/tagout program/procedures.

EXERCISE 2.18-F To differentiate between the following terms, complete the table below.

ANSWER 2.18-F

Lockout/Tagout Terminology	
Term	**Definition**
Personnel protection	Lockouts to protect persons working on or around the equipment (i.e., supply voltage to electric equipment).
Equipment protection	Lockouts to protect equipment because a portion of that equipment is not useable (i.e., cooling system for an engine).
Operations	Normal production operations are not covered unless an employee is required to bypass a guard or safety device or to place part if his/her body into an area where work is actually performed or where an associated danger zone exists. 29 CFR 1910.147, (2) "Application.
Administrative	Lockouts of one of an identical set of equipment to equalize "run" times.
Confined space	Lockout used in a confined space to prevent equipment operation when hazardous conditions exist (i.e., flammable gas present).

EXERCISE 2.18-G Define independent verification.

ANSWER 2.18-G Independent verification is the act of checking that a given operation conforms to established criteria, as well as checking a component position independently of activities related to establishing the component's position.

EXERCISE 2.18-H Discuss when independent verification is required.

ANSWER 2.18-H Components that are critical to ensure safe and reliable operation should receive an independent verification of their position when circumstances warrant. The components should be identified explicitly in facility procedures or other official documents so that necessary interpretation of requirements will be minimized.

EXERCISE 2.18-I Scenario: An overhead light socket has burned out due to dust, condensation, and/or age. The light is turned off/on by a wall switch. A repairman is coming in to replace the socket. Assuming that a lockout/tagout program is in place, where must the lockout/tagout device be placed to effectively isolate the socket from the energy source and what additional checks should be made to verify that the isolation is effective.

ANSWER 2.18-I The wall switch should be placed in the OFF position and the circuit breaker in the distribution panel should be turned OFF and locked/tagged out and voltage checks (using a voltmeter) should be made at the socket and the wall switch to verify that zero volts (ø v.) is present.

Competency 4.6 **EH residents shall demonstrate the ability to conduct inspections on the use of personal protective equipment (PPE).**

1. Supporting Knowledge and Skills

a. Given a type of personal protective equipment, demonstrate the proper use (donning and doffing) of the equipment.

b. Given a respirator for use, verify that the equipment is in good working order, the routine inspection has been performed, and the respirator is appropriate for the specified activity/environment.

c. Conduct an assessment of one or more of the following areas of a personal protective equipment program.
- Written procedures
- Respirator selection
- User training
- Respirator cleaning
- Respirator storage
- Inspections

2. Self-Study Activities (corresponding to the intent of the above competency)

NOTE: Below are three web sites containing many of the references you may need.

Web Sites		
Organization	**Site Location**	**Notes**
Department of Energy	http://cted.inel.gov/cted/index.html	DOE Standards, Guides, and Orders.
OSHA	http://www.osha-slc.gov/	OSHA documents and search engine
U.S. House of Representatives	http://law.house.gov/cfr.htm	Searchable Code of Federal Regulations

Read Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA, **scan** Subpart I, "Personal Protective Equipment," of 29 CFR 1910, and **read** 29 CFR 1910.120 (g), Engineering controls, work practices, and personal protective equipment for employee protection, Appendix B, "General Description and Discussion of the Levels of Protection and Protective Gear."

Note that 29 CFR 1926, also contains similar regulations governing the use of PPE in the construction industry.

EXERCISE 4.6-A Describe the various types and intended purpose of personal protective equipment (PPE).

EXERCISE 4.6-B Referring to Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA, in the following table, match (from the following list) the appropriate type of respiratory protection to the given limitation:

- Self-contained breathing apparatus (SCBA)
- Positive-pressure, supplied-air respirator (SAR)
- Air-purifying respirator
- Closed-circuit SCBA
- Escape-only SCBA

Matching Respiratory Protection with Limitation	
Disadvantages	**Type of Respiratory Protection**
At very cold temperatures, scrubber efficiency may be reduced and CO_2 breakthrough may occur.	
Can only be used against gas and vapor contaminants with adequate warning properties.	
Provides only 5 to 15 minutes of respiratory protection.	
Bulky, heavy, and may impair movement in confined spaces.	
Air line is vulnerable to damage, chemical contamination, and degradation.	

EXERCISE 4.6-C Have your supervisor or other competent person check you out using the following checklist while you inspect a fully encapsulating suit with SCBA ensemble. Begin as soon as your supervisor indicates.

SAMPLE PPE INSPECTION CHECKLISTS (From NIOSH)

PPE	SAT/UNSAT
CLOTHING	
Before Use: Determine that the clothing material is correct for the specified task at hand. Visually inspect for: - imperfect seams - nonuniform coatings - tears - malfunctioning closures Hold up to light and check for pinholes. Flex product: - observe for cracks - observe for other signs of shelf deterioration If the product has been used previously, inspect inside and out for signs of chemical attack: - discoloration - swelling - stiffness	
During the work task, periodically inspect for: Evidence of chemical attack such as discoloration, swelling, stiffening, and softening. Keep in mind, however, that chemical permeation can occur without any visible effects. Closure failure. Tears. Punctures. Seam discontinuities.	

SAMPLE PPE INSPECTION CHECKLISTS (From NIOSH)	
PPE	**SAT/UNSAT**
GLOVES	
Before use: Pressurize glove to check for pinholes. Either blow into glove and then roll gauntlet towards fingers or inflate glove and hold under water. In either case, no air should escape.	
FULLY ENCAPSULATING SUITS	
Before use: Check the operation of pressure relief valves. Inspect the fitting of wrists, ankles, and neck. Check faceshield, if so equipped, for: - cracks - crazing - fogginess	
RESPIRATORS	
SCBA	
Inspect SCBAs: - before and after each use - at least monthly when in storage - every time they are cleaned Check all connections for tightness. Check material conditions for: - signs of pliability - signs of deterioration - signs of distortion Check for proper setting and operation of regulators and valves (according to manufacturers' recommendations). Check operation of alarm(s). Check faceshields and lenses for: - cracks - crazing - fogginess	

SAMPLE PPE INSPECTION CHECKLISTS (From NIOSH)	
PPE	**SAT/UNSAT**
SUPPLIED-AIR RESPIRATORS	
Inspect SARs: - daily when in use - at least monthly when in storage - every time they are cleaned Inspect air lines prior to each use for cracks, kinks, cuts, frays, and weak areas. Check for proper setting and operation of regulators and valves (according to manufacturers' recommendations). Check all connections for tightness. Check material conditions for: - signs of pliability - signs of deterioration - signs of distortion Check faceshields and lenses for: - cracks - crazing - fogginess	

SAMPLE PPE INSPECTION CHECKLISTS (From NIOSH)	
PPE	**SAT/UNSAT**
AIR-PURIFYING RESPIRATORS	
Inspect air-purifying respirators: - before each use to be sure they have been adequately cleaned - after each use - during cleaning - monthly if in storage for emergency use Check material conditions for: - signs of pliability - signs of deterioration - signs of distortion Examine cartridges or canisters to ensure that: - they are the proper type for the intended use - the expiration date has not been passed - they have not been opened or used previously Check faceshields and lenses for: - cracks - crazing - fogginess	

EXERCISE 4.6-D Referring to Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA, [redacted] identify the general steps to be taken in donning a fully encapsulating suit with SCBA ensemble.

EXERCISE 4.6-E Have your supervisor or other competent person check you out using the following checklist while you don a fully encapsulating suit with SCBA ensemble. Begin as soon as your supervisor indicates.

SAMPLE DONNING PROCEDURES (From NIOSH)		
#	**Step**	**SAT/UNSAT**
1.	Inspect the clothing and respiratory equipment before donning (see ***D***.	
2.	Adjust hard hat or headpiece, if worn, to fit user's head.	
3.	Open back closure used to change air tank (if suit has one) before donning suit.	
4.	Standing or sitting, step into the legs of the suit; ensure proper placement of the feet within the suit and then gather the suit around the waist.	
5.	Put on chemical-resistant safety boots over the feet of the suit. Tape the leg cuff over the tops of the boots.	
	If additional chemical-resistant boots are required, put these on now.	
	Some one-piece suits have heavy-soled protective feet. With these suits, wear short, chemical-resistant safety boots inside the suit.	
6.	Put on air tanks and harness assembly of the SCBA. Don the facepiece and adjust it to be secure, but comfortable. Do *not* connect the breathing hose. Open valve on air tank.	
7.	Perform negative and positive respirator facepiece seal test procedures.	
	To conduct a negative-pressure test, close the inlet part with the palm of the hand or squeeze the breathing tube so it does not pass air, and gently inhale for about 10 seconds. Any inward rushing of air indicates a poor fit. Note that a leaking facepiece may be drawn tightly to the face to form a good seal, giving a false indication of adequate fit.	
	To conduct a positive-pressure test, gently exhale while covering the exhalation valve to ensure that a positive pressure can be built up. Failure to build a positive pressure indicates a poor fit.	

SAMPLE DONNING PROCEDURES (From NIOSH)		
#	**Step**	**SAT/UNSAT**
8.	Depending on type of suit:	
	- Put on long-sleeved inner gloves (similar to surgical gloves).	
	- Secure gloves to sleeves, for suits with detachable gloves (if not done prior to entering the suit).	
	- Additional overgloves, worn over attached suit gloves, may be donned later.	
9.	Put sleeves of suit over arms as assistant pulls suit up and over the SCBA. Have assistant adjust suit around SCBA and shoulders to ensure unrestricted motion.	
10.	Put on hard hat, if needed.	
11.	Raise hood over head carefully so as not to disrupt face seal of SCBA mask. Adjust hood to give satisfactory comfort.	
12.	Begin to secure the suit by closing all fasteners on opening until there is only adequate room to connect the breathing hose. Secure all belts and/or adjustable leg, head, and waistbands.	
13.	Connect the breathing hose while opening the main valve.	
14.	Have assistant first ensure that wearer is breathing properly and then make final closure of the suit.	
15.	Have assistant check all closures.	
16.	Have assistant observe the wearer for a period of time to ensure that the wearer is comfortable, psychologically stable, and that the equipment is functioning properly.	

EXERCISE 4.6-F Referring to Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA, [redacted] identify the general steps to be taken in doffing a fully encapsulating suit with SCBA ensemble.

EXERCISE 4.6-G Have your supervisor or other competent person check you out using the following checklist while you doff a fully encapsulating suit with SCBA ensemble. Begin as soon as your supervisor indicates.

SAMPLE DOFFING PROCEDURES (From NIOSH)		
If sufficient air supply is available to allow appropriate decontamination before removal:		
#	**Step**	**SAT/UNSAT**
1.	Remove any extraneous or disposable clothing, boot covers, outer gloves, and tape.	
2.	Have assistant loosen and remove the wearer's safety shoes or boots.	
3.	Have assistant open the suit completely and lift the hood over the head of the wearer and rest it on top of the SCBA tank.	
4.	Remove arms, one at a time, from suit. Once arms are free, have assistant lift the suit up and away from the SCBA backpack - avoiding any contact between the outside surface of the suit and the wearer's body - and lay the suit out flat behind the wearer. Leave internal gloves on, if any.	
5.	Sitting, if possible, remove both legs from the suit.	
6.	Follow procedure for doffing SCBA.	
7.	After suit is removed, remove internal gloves by rolling them off the hand, inside out.	
8.	Remove internal clothing and thoroughly cleanse the body.	
If the low-pressure warning alarm has sounded, signifying that approximately five minutes of air remain:		
1.	Remove disposable clothing.	
2.	Quickly scrub and hose off, especially around the entrance/exit zipper.	

3.	Open the zipper enough to allow access to the regulator and breathing hose.	

SAMPLE DOFFING PROCEDURES (From NIOSH)		
If the low-pressure warning alarm has sounded, signifying that approximately five minutes of air remain:		
#	**Step**	**SAT/UNSAT**
4.	Immediately attach an appropriate canister to the breathing hose (the type and fittings should be predetermined.) Although this provides some protection against any contamination still present, it voids the certification of the unit.	
5.	Follow Steps 1 through 8 of the regular doffing procedure above. Take extra care to avoid contaminating the assistant and wearer.	

EXERCISE 4.6-H Under the oversight of your supervisor and using Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA, [redacted] conduct assessments of the adequacy of DOE's and the contractor's personal protective equipment program. Report your results of both assessments to your supervisor.

3. Summary

(From NIOSH/OSHA/USCG/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*)

Use of PPE is required by Occupational Safety and Health Administration (OSHA) regulations in 29 CFR 1910 and reinforced by U.S. Environmental Protection Agency (EPA) regulations in
40 CFR 300, which include requirements for all private contractors working on Superfund sites to conform to applicable OSHA provisions and any other federal or state safety requirements deemed necessary by the lead agency overseeing the activities.

No single combination of protective equipment and clothing is capable of protecting against all hazards. Thus, PPE should be used in conjunction with other protective methods. The use of PPE can itself create significant worker hazards, such as heat stress, physical and psychological stress, and impaired vision, mobility, and communication. In general, the greater the level of PPE protection, the greater are the associated risks. For any given

situation, equipment and clothing should be selected that provide an adequate level of protection. Overprotection as well as underprotection can be hazardous and should be avoided.

4. Exercise Solutions

EXERCISE 4.6-A Describe the various types and intended purpose of personal protective equipment (PPE).

ANSWER 4.6-A

Types and Purpose of Personal Protective Equipment (PPE)		
Body Part Protected	**PPE**	**Purpose**
Eyes and face	Face shield	Protects against chemical splashes.
	Splash hood	Protects against chemical splashes.
	Safety glasses	Protect eyes against large particles and projectiles.
	Goggles	Can protect against vaporized chemicals, splashes, large particles, and projectiles.
	Sweat bands	Prevents sweat-induced eye irritation and vision impairment.
Respiratory	Self-contained breathing apparatus	Provides the highest available level of protection against airborne contaminants and oxygen deficiency.
	Supplied-air respirators	Protect against most airborne contaminants.
	Air-purifying respirators	Protect against specific chemicals and up to specific concentrations.
Hands and arms	Gloves and sleeves	Protect hands and arms from chemical contact.
Feet	Safety boots	Protect feet from contact with chemicals and from compression, crushing, or puncture by falling, moving, or sharp objects.

Types and Purpose of Personal Protective Equipment (PPE)		
Body Part Protected	**PPE**	**Purpose**
	Disposable shoe or boot covers	Protect safety shoes or boots from contamination.

Types and Purpose of Personal Protective Equipment (PPE)		
Body Part Protected	**PPE**	**Purpose**
Head	Safety helmet	Protects head from blows.
	Hood	Protects against chemical splashes, particulates, and rain.
	Protective hair covering	Protects hair against chemical contamination, entanglement in machinery or equipment, or from interfering with vision and with the functioning of respiratory devices.
Full body	Fully encapsulating suit	Protects against splashes, dust, gases, and vapors.
	Nonencapsulating suit	Protects against splashes, dust, and other materials, but not against gases and vapors.
	Aprons, leggings, and sleeve protectors	Provides additional splash protection of chest, forearms, and legs.

EXERCISE 4.6-B

Referring to Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA, [redacted] in the following table, match (from the following list) the appropriate type of respiratory protection to the given limitation:

- Self-contained breathing apparatus (SCBA)
- Positive-pressure, supplied-air respirator (SAR)
- Air-purifying respirator
- Closed-circuit SCBA
- Escape-only SCBA

ANSWER 4.6-B

Matching Respiratory Protection with Condition	
Disadvantages	**Type of Respiratory Protection**
At very cold temperatures, scrubber efficiency may be reduced and CO_2 breakthrough may occur.	Closed-circuit SCBA
Can only be used against gas and vapor contaminants with adequate warning properties.	Air-purifying
Provides only 5 to 15 minutes of respiratory protection.	Escape-only SCBA
Bulky, heavy, and may impair movement in confined spaces.	Self-contained breathing apparatus
Air line is vulnerable to damage, chemical contamination, and degradation.	Positive-pressure, supplied-air respirator

EXERCISE 4.6-C Have your supervisor or other competent person check you out using the following checklist while you inspect a fully encapsulating suit with SCBA ensemble. Begin as soon as your supervisor indicates.

SAMPLE PPE INSPECTION CHECKLISTS (From NIOSH)

PPE	SAT/UNSAT
CLOTHING	
Before Use: Determine that the clothing material is correct for the specified task at hand. Visually inspect for: - imperfect seams - nonuniform coatings - tears - malfunctioning closures Hold up to light and check for pinholes. Flex product: - observe for cracks - observe for other signs of shelf deterioration If the product has been used previously, inspect inside and out for signs of chemical attack: - discoloration - swelling - stiffness	
During the work task, periodically inspect for: Evidence of chemical attack such as discoloration, swelling, stiffening, and softening. Keep in mind, however, that chemical permeation can occur without any visible effects. Closure failure. Tears. Punctures. Seam discontinuities.	

SAMPLE PPE INSPECTION CHECKLISTS (From NIOSH)	
PPE	**SAT/UNSAT**
GLOVES	
Before use: Pressurize glove to check for pinholes. Either blow into glove and then roll gauntlet towards fingers or inflate glove and hold under water. In either case, no air should escape.	
FULLY ENCAPSULATING SUITS	
Before use: Check the operation of pressure relief valves. Inspect the fitting of wrists, ankles, and neck. Check faceshield, if so equipped, for: - cracks - crazing - fogginess	
RESPIRATORS	
SCBA	
Inspect SCBAs: - before and after each use - at least monthly when in storage - every time they are cleaned Check all connections for tightness. Check material conditions for: - signs of pliability - signs of deterioration - signs of distortion Check for proper setting and operation of regulators and valves (according to manufacturers' recommendations). Check operation of alarm(s). Check faceshields and lenses for: - cracks - crazing - fogginess	

SAMPLE PPE INSPECTION CHECKLISTS (From NIOSH)	
PPE	**SAT/UNSAT**
SUPPLIED-AIR RESPIRATORS	
Inspect SARs: - daily when in use - at least monthly when in storage - every time they are cleaned Inspect air lines prior to each use for cracks, kinks, cuts, frays, and weak areas. Check for proper setting and operation of regulators and valves (according to manufacturers' recommendations). Check all connections for tightness. Check material conditions for: - signs of pliability - signs of deterioration - signs of distortion Check faceshields and lenses for: - cracks - crazing - fogginess	

SAMPLE PPE INSPECTION CHECKLISTS (From NIOSH)	
PPE	**SAT/UNSAT**
AIR-PURIFYING RESPIRATORS	
Inspect air-purifying respirators: - before each use to be sure they have been adequately cleaned - after each use - during cleaning - monthly if in storage for emergency use Check material conditions for: - signs of pliability - signs of deterioration - signs of distortion Examine cartridges or canisters to ensure that: - they are the proper type for the intended use - the expiration date has not been passed - they have not been opened or used previously Check faceshields and lenses for: - cracks - crazing - fogginess	

ANSWER 4.6-C A supervisor-completed checklist.

EXERCISE 4.6-D Referring to Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA, [redacted] identify the general steps to be taken in donning a fully encapsulating suit with SCBA ensemble.

ANSWER 4.6-D Sample Donning Procedures:

1. Inspect the clothing and respiratory equipment before donning.
2. Adjust hard hat or headpiece if worn, to fit user's head.
3. Open back closure used to change air tank (if suit has one) before donning suit.
4. Standing or sitting, step into the legs of the suit; ensure proper placement of the feet within the suit and then gather the suit around the waist.

5. Put on chemical-resistant safety boots over the feet of the suit. Tape the leg cuff over the tops of the boots.
   - If additional chemical-resistant boots are required, put these on now.
   - Some one-piece suits have heavy-soled protective feet. With these suits, wear short, chemical-resistant safety boots inside the suit.
6. Put on air tanks and harmless assembly of the SCBA. Don the facepiece and adjust it to be secure, but comfortable. Do ***n***o connect the breathing hose. Open valve on air tank.
7. Perform negative and positive respirator facepiece seal test procedures.
   - To conduct a negative-pressure test, close the inlet part with the palm of the hand or squeeze the breathing tube so it does not pass air, and gently inhale for about 10 seconds. Any inward rushing of air indicates a poor fit. Note that a leaking facepiece may be drawn tightly to the face to form a good seal, giving a false indication of adequate fit.
   - To conduct a positive-pressure test, gently exhale while covering the exhalation valve to ensure that a positive pressure can be built up. Failure to build a positive pressure indicates a poor fit.
8. Depending on type of suit:
   - Put on long-sleeved inner gloves (similar to surgical gloves).
   - Secure gloves to sleeves, for suits with detachable gloves (if not done prior to entering the suit).
   - Additional overgloves, worn over attached suit gloves, may be donned later.
9. Put sleeves of suit over arms as assistant pulls suit up and over the SCBA. Have assistant adjust suit around SCBA and shoulders to ensure unrestricted motion.
10. Put on hard hat, if needed.
11. Raise hood over head carefully so as not to disrupt face seal of SCBA mask. Adjust hood to give satisfactory comfort.
12. Begin to secure the suit by closing all fasteners on opening until there is only adequate room to connect the breathing hose. Secure all belts and/or adjustable leg, head, and waistbands.
13. Connect the breathing hose while opening the main valve.
14. Have assistant first ensure that wearer is breathing properly and then make final closure of the suit.
15. Have assistant check all closures.

16. Have assistant observe the wearer for a period of time to ensure that the wearer is comfortable, psychologically stable, and that the equipment is functioning properly.

EXERCISE 4.6-E Have your supervisor check you out using the following checklist while you don a fully encapsulating suit with SCBA ensemble. Begin as soon as your supervisor indicates.

ANSWER 4.6-E A supervisor-completed checklist.

EXERCISE 4.6-F Referring to Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA, [redacted] identify the general steps to be taken in doffing a fully encapsulating suit with SCBA ensemble.

ANSWER 4.6-F A supervisor-completed checklist.

EXERCISE 4.6-G Have your supervisor check you out using the following checklist while you doff a fully encapsulating suit with SCBA ensemble. Begin as soon as your supervisor indicates.

ANSWER 4.6-G A supervisor-completed checklist.

EXERCISE 4.6-H Under the oversight of your supervisor and using Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA, [redacted] conduct assessments of the adequacy of DOE's and the contractor's personal protective equipment program. Report your results of both assessments to your supervisor.

ANSWER 4.6-H Your supervisor will evaluate how well you conducted the assessments and the adequacy of your specific results.